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MODERN DRAINAGE INSPECTION

AND

SANITARY SURVEYS.

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DEFECTIVE BRANCH DRAINS.

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MODERN

DRAINAGE INSPECTION

AND

SANITARY SURVEYS.

BY

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PREFACE.

THE substance of the following pages has already appeared in *The Sanitary Record and Journal of Sanitary and Municipal Engineering*, in the form of a short series of articles, in which it was endeavoured to give a few practical hints upon drain testing, and the carrying out of sanitary surveys.

The kind appreciation shown to these articles, gives every reason to believe that they have been of some slight service to my fellow-workers, and would seem to warrant their publication in book form. With this object, they have been carefully revised, partly re-written, and greatly added to, in order to present them in a more complete form. The illustrations have been almost doubled in number, and have, with very few exceptions, been specially drawn for the present work.

To all who are engaged or interested in the subject of drainage, these pages are meant to appeal, and I hope that their perusal may also prove useful to householders and laymen generally.

On the assumption that he who inspects is an *Inspector*, I have used that nomenclature throughout the book, applying it alike to the Engineer, Surveyor, and Inspector of Nuisances.

GERARD J. G JENSEN.

14, *Victoria Street, S.W.*,
February, 1899.

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MODERN DRAINAGE INSPECTION
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CHAPTER I.

INTRODUCTORY.

THAT defective Sanitation is dangerous to health, is a well-known and established fact. Indifferent Sanitation means indifferent air and water, which, in their turn, mean indifferent health, sickness, and death. Typhoid fever, diphtheria, cholera, consumption, and all other infectious diseases, are all in one way or another the direct outcome of imperfect Sanitation. They are all *preventable*, and cannot be regarded as natural or accidental any more than death by assault or destruction of life by arson. Their very existence is therefore a disgrace, and a proof of ignorance or of negligence.

In so far as house drainage is concerned, this want of knowledge or care is due partly to the householder, and greatly, I regret to say, to those who, although lacking ability, profess to give sanitary advice. On the one hand, we have the householder who cares more for the colour of the carpet than the soundness of the drain or the cleanliness of the water-supply cistern. The ignorant property-owner who still regards Sanitation as a new-fangled fad, and the householder who enlists the services of a jobber, or

so-called "practical man," to devise a delicate hydraulic machine necessitating as skilled brains to devise as any other class of machine.

On the other hand, we have the irresponsible and ignorant jobber, who is at all times ready and anxious to proffer his services as a sanitary specialist, even though his only knowledge of sanitation is that derived from the sale of drain pipes.

Modest indeed is the plumber, house agent, and chimney sweep now-a-days (though doubtless the more trustworthy for his modesty) who does not boldly assume the *rôle* and title of "Sanitary Engineer." Foolish indeed—and to be pitied—the householder who employs him in that capacity. One wonders who is more to blame, the "Engineer," whose modesty stands so severe a strain as to enable him to undertake the work, or the householder who entrusts vital interests to such hands. It is only when drain-begotten disease breaks out in his home that the latter realises that there is danger in house drainage, and that he has entrusted his work into hands which have sown the seeds of many a harvest that death has gathered in. To the uninitiated drainage inspection may *seem* easy, but the gravity of the issues involved are such as to require the most skilful and conscientious work.

To look at the joints of the soil-pipe, walk over the house, and perhaps even apply a smoke rocket to the drain (as I have known the work carried out by the above-mentioned "Engineers") is *not* drainage inspection. Such proceeding is in all cases dishonesty, and in many manslaughter, as some confiding person may find his or her health and life departing should the drains not be sound. *Real* drainage inspection and drain testing is different. In such an inspection not one of the many items which constitute the sanitary

arrangements of a house, or which might affect the health of the inmates, is overlooked. Each pipe, each joint, and each fitting is examined, tried, tested; and approved or condemned.

Drainage inspection, in short, demands thorough and conscientious work, and should therefore only be undertaken by properly qualified men.

The qualifications are :—

1. *A thorough knowledge of the principles of house drainage*, so that the Inspector may constantly keep before him the conditions upon which are dependent the safe and speedy removal of all waste matter and its ultimate disposal. This will include a knowledge of mathematics, hydraulics, and aerostatics, some chemistry and bacteriology.
2. *A thorough knowledge of details of plumbing and drainage work.* This is necessary to distinguish between good and bad work and fittings. It must include a knowledge of the use and abuse of appliances; of the properties of the materials made use of, and of the crafts employed—plumbing, masonry, carpentry, &c.
3. *A sound knowledge of architecture and building construction*, as it will often be the duty of the Inspector to advise upon the rectification of structural defects.
4. *Conscientiousness and honesty.* — These, it need hardly be said, are essential for trustworthiness. The Inspector must not shirk unpleasant work, which is frequent in drainage inspection, and must be able to withstand bribery, for bribes may be, and frequently are, offered to him in various forms.

5. *Fairness and impartiality.*—The Inspector must be perfectly unbiassed, and must judge each appliance and all work upon their own merits. He must look at all matters from all sides, and consider each question in all its bearings.

6. *Tact, patience, and courteousness.*—The first to enable the Inspector to perform disagreeable duties in the least unpleasant way. The others to keep cool and collected when, in the course of his duties, he meets with impatience and opposition.

7. *Inventive ability and ready resource*, for tracing defects in drainage, and to overcome ever new combinations of faults and errors.

In addition to these, the Inspector must be fond of his work, if not enthusiastic. He should possess powers of close observation and readiness to receive new ideas. He should keep in touch with sanitary literature and his fellow-workers, and, when opportunity offers, take part in the discussion of sanitary questions. This will keep alive an interest in his work, and promote that efficiency which alone will ensure success in his work.

When making an examination respecting the sanitary condition of the drains and fitments of any building, it is necessary that the whole method of procedure should be systematic and thorough, or the final results will be unreliable and altogether unsatisfactory. Nothing in connection with the inspection must be left to guesswork, or taken for granted, and information given by those who profess to know must be verified, however probable the statements may appear. Such information is often very valuable for giving clues, and should always be gratefully received, and even courted; but, as already stated, the

Inspector must satisfy himself of its accuracy, and regard as facts only such information of which he himself has found proof. *Upon the thoroughness and conscientiousness of his work is dependent the health, and, it may be, the lives of the inmates of the house.* That is the only fact which the Inspector may take for granted, and he should never for a moment lose sight of it.

In making an inspection, an ocular examination of portions of the underground drains is quite as important as the application of efficient tests. The latter can only ascertain if the drains are sound, but will give no clue as to the general condition, construction, and arrangement of the drains, which may include pipes excessive in size or insanitary in shape; sharp bends, and faulty (though air and water-tight) junctions. For the ferreting out of such defects, a familiarity with the errors which are likely to be met with is hardly less important than a knowledge of what is right and proper. This, to a great extent, can only be acquired by experience. Experience also, coupled with a thorough knowledge of the principles of house drainage, will also be the only safe guide in forming an opinion regarding the efficiency of any appliance or arrangement which may be found. What may be inexpedient or even dangerous in one case, may be admissible in another, and unless the Inspector appreciates the object that is to be attained, he may condemn a perfectly suitable arrangement or fitting simply because it does not correspond with what he has seen used in similar circumstances. In a tier of closets discharging into one soil-pipe, for instance, I have found each syphonage pipe carried to the outside of the house, and there fitted with a mica flap valve. So long as these valves remain in order, they answer the purpose well. Therefore—although it would be better to branch the pipes

into one continued to the roof—they may suffice, if the inmates of the house are warned and made to understand that the valves require frequent inspection, and occasional cleansing and lubrication. Such advice to sensible people will be perfectly righteous if the owner of the house cannot well afford new anti-syphonage pipes. At the same time, there is no excuse for patchwork or make-shifts where cost need not be unduly studied, for, as Dr. Parkes has said: "It has been proved over and over again that nothing is so costly in all ways as disease, and that nothing is so remunerative as the outlay that augments health."

CHAPTER II.

TESTING APPARATUS.

NEXT to the personal qualifications stated in the foregoing chapter, there is nothing so essential for the Inspector's equipment as efficient and reliable apparatus with which to apply such tests as may be necessary to disclose hidden defects. The object of this chapter is, therefore, to describe briefly some of the most reliable appliances used. Having done this, they need not be

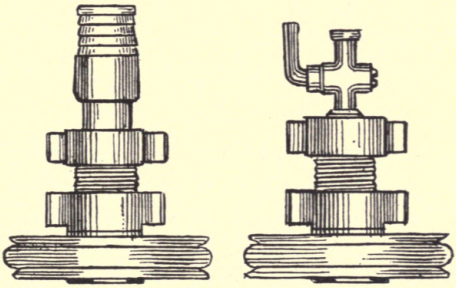

FIG. 1.

subsequently referred to in detail, and the reader will be provided with a source of ready reference should he require it.

For obvious reasons, I do not recommend one apparatus above another. All those described are good, and the would-be Inspector must use his own discretion in choosing

the appliances which he considers best suited to his purpose.

PLUGS.

Burn Bros.' *No.* 350 *Drain Plug*, shown in Fig. 1 consists of two brass plates with slanting edges, between which rests a soft rubber ring. A hollow screwed pinion, which is fixed to the back plate, passes through the plug

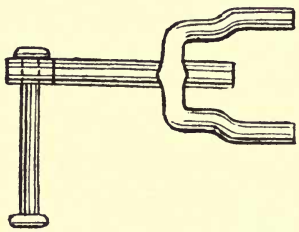

FIG. 2.

and serves to draw the two plates together when the fly-nut is screwed up. The pinion is supplied with a cap and stop-cock for letting off water when the plug is used for the water test, and with a union for connection with the tube of a smoke machine when used for smoke testing. The stop-cock and union are, of course, interchangeable. By screwing up the fly-nut the two plates are pressed towards each other, thus expanding the rubber ring and forcing it out against the sides of the drain. In this way an air and water-tight seal is formed. A key (Fig. 2) is provided for screwing up the nut.

Jones' Plug is similar in principle, although, as will be seen from Fig. 3, it differs considerably from the foregoing

in detail. The rubber ring is hollow and of peculiar shape, and is, moreover, held in position by a groove in the discs, which in this case are made of galvanised iron. The fly-

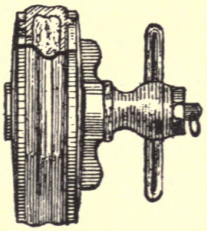

FIG. 3.

nut has also longer wings, which allow the plug to be screwed up by hand. The spindle is provided with a brass cap for letting off water, or for applying the smoke or air tests.

The "Grip" (Fig. 4), much like Burn Bros.' in shape, is made of galvanised iron, and has a narrower

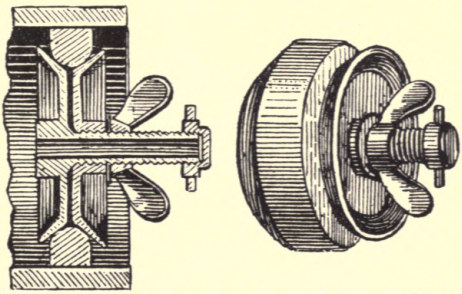

FIG. 4.

spindle. Its chief characteristic is the outer edge of the rubber ring, which, being flat, provides a considerable gripping surface against the sides of the drain.

The "Addison" (Fig. 5), like the "Grip," claims great power of adhesion through the comparatively large surface of rubber (A) brought into contact with the sides of the drain. It differs, however, in design, and it is

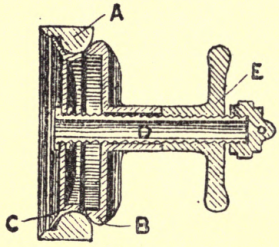

FIG. 5.

claimed that by the peculiar shape of the discs (B and C) the rubber is not likely to be caught and pinched. The discs are made of galvanised iron, the spindle (D) of

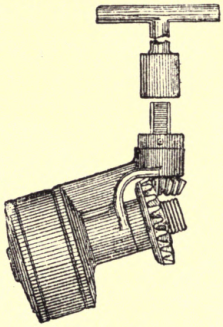

FIG. 6.

gun-metal, and the nut and cap of brass. Having large wings to the nut (E) no key is necessary to screw it up.

The "Angle" Plug shown in Fig. 6, which is made by Messrs. Burn Brothers, is very useful for stopping drains at bends and through junctions. The illustration explains itself.

The "Reliable" drain stopper, shown in Fig. 7, differs from all the foregoing plugs in that all screwing and expansion is dispensed with. The plug consists of a metal disc (B), with grooved edge in which is fixed a flat india-rubber ring (C), of rather larger dimensions than the drain to be plugged. A capstan handle (A) is screwed into the centre of the disc, and serves to keep the plug upright in the drain. When once the stopper has been jammed into the drain, it cannot be displaced by pressure from within.

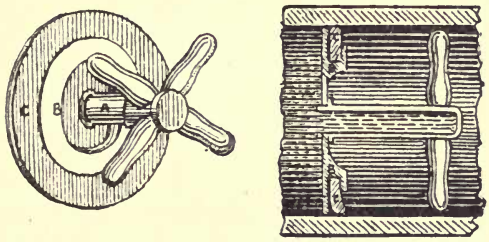

FIG. 7.

This, in fact, rather tends to tighten the plug, so long as the handle remains in position. To remove the plug, the handle is unscrewed and the water allowed to escape, after which the plate is easily withdrawn.

BAGS.

These are usually made of water-proof canvas or india-rubber. Their shape may be globular or cylindrical, but the latter form is preferable, as it provides a larger surface for adhesion to the sides of the drain. Each bag is fitted with a tap, to which an india-rubber tube and air pump are attached when the bag is to be inflated. When the drain

has been plugged, the tap is closed and the pump detached for use with another bag if necessary. Figs. 8 and 9 illustrate the two forms of bags, which are shown inflated.

Fig. 10 shows *Jones' No. 2 bag*, which is provided with a telescopic centre rod and a dished rubber washer, which

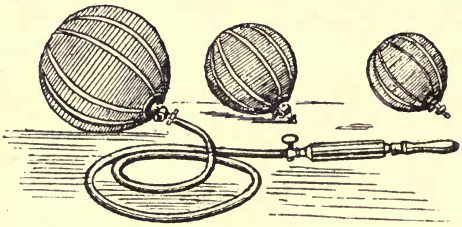

FIG. 8.

latter forms a plug in itself. The washer is also intended to protect the bag. The illustration shows the bag as it appears when deflated.

Special mention must be made of the "*Eclipse*" bag, shown in Fig. 11. This bag consists of two brass spigot

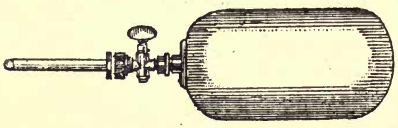

FIG. 9.

flanges, over which are drawn two specially-prepared rubber tubes. A brass tube A passes right through the plug, and to it is attached the smoke-machine tube or a pet-cock, for use with the smoke test or the water test respec-

tively. Inflation is obtained by the usual air pump and flexible tube through a brass tube (B) in one of the flanges.

The plug is provided with loose canvas covers to fit various sizes of drain pipes, and has a range of expansion

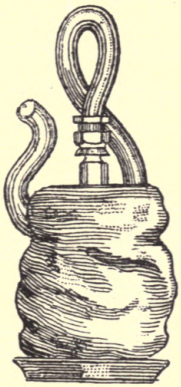

FIG. 10.

which renders it suitable for any drain from 4in. to 9in. in diameter.

The chief value of the bag, however, is that by its means leakages in drains may be localised. Being pro-

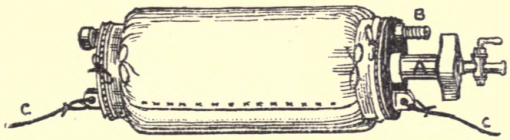

FIG. 11.

vided with an eyelet at each end, pieces of wire or strong twine (C) may be attached to the plug, and the latter drawn to any given point in the drain, there to be inflated.

Supposing now that the plug is drawn into the drain 10ft. from its inlet, the bag is inflated there and the 10ft. length of drain tested. If that portion is proved sound, the plug is released, drawn in another 10ft., and so on, until the leakage has been found.

SMOKE MACHINES.

The "Rocket," better named "*Smoke Case,*" is the simplest form of smoke machine. It is very useful

FIG. 12.

and effective for tracing defects in short lengths of drains, soil-pipes, and waste-pipes. The "Rocket" consists of a

FIG. 13.

cylindrical case some 7in. long and 2in. in diameter, filled with a compound which on ignition generates dense volumes of smoke. Two strips of wood are attached,

which, when spread out, keep the rocket off the invert of the drain, leaving a clear passage for water, should any find its way into the drain. The "Rocket" is shown in Fig. 12.

Burnet and Groom's Tester (Fig. 13), which may be described as a "Rocket," consists of a tin cylinder, 7in. long, 1½in. in diameter, attached to a loose handle, and filled with a combustible, smoke-generating compound. The cylinder is fired by a fuse, and thrust through a water-closet or other trap to the drain side of the latter. Here it burns

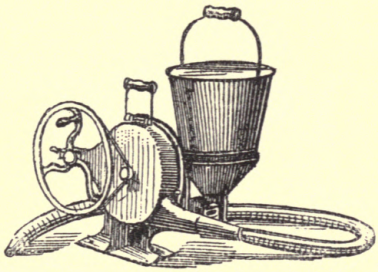

FIG. 14.

or some ten minutes, during which the Inspector must search for traces of escaping smoke. When spent, the case is withdrawn, and the now empty cylinder detached from the handle, which, being telescopic, folds up into a convenient form for carrying.

The "Asphyxiator" is what may be properly called a "machine," the construction and working of which is made clear by Fig. 14.

In this machine the smoke is generated by burning "touch paper"—sulphur, tobacco, or tar paper—in the bucket-shaped receptacle at the back of the illustration.

By turning the wheel, a fan is set in rapid motion, causing a strong current of air to pass through the smoke chamber and driving the smoke into the drain through the india-rubber tube. The "Asphyxiator" is made in various sizes to suit different requirements, and may claim to be the first apparatus used for testing drains with smoke.

The "Grahtryx" smoke machine (Fig. 15) is not unlike the "Asphyxiator," inasmuch as smoke is generated with

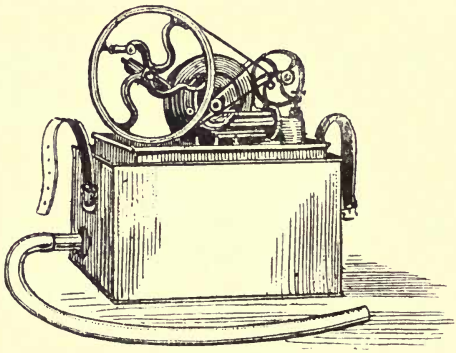

FIG. 15.

"touch paper" and the necessary air current produced by a fan. The smoke chamber, however, is completely closed, and the smoke kept in check by a water seal. The whole apparatus can be closed into a convenient form for carrying by inverting and placing the inner part of the machine into the outer case. The latter is then secured by the leather strap shown.

Jones' "Rotary-action" smoke machine (Fig. 16) is very similar to the "Asphyxiator" and the "Grahtryx" machines.

The principles of construction and working are in fact the same, although the details differ. The machine is compact and efficient.

The "Eclipse" drain tester (Fig. 17) substitutes a double-action bellows for the wheel and fan of the three former

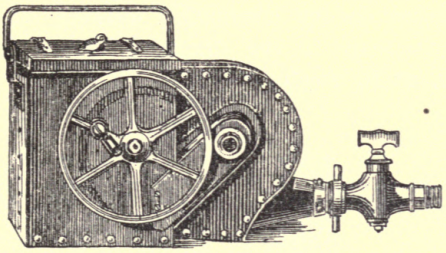

FIG. 16.

machines. The combustion chamber, moreover, is formed by a copper cylinder, fixed in a square box of similar

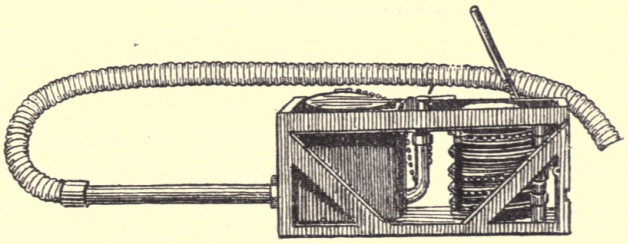

FIG. 17.

material, and covered by a loose copper drum. The square box is filled with water, which keeps the combustion chamber cool, and provides a sufficient seal to keep in the smoke, which is generated by burning "touch paper" or oily cotton

waste. By pumping the bellows, the smoke is forced into the drain through a stand-pipe in the smoke chamber and the flexible tube shown in the illustration. With the "Eclipse" machine drains may also be tested without the use of smoke. In this case all openings on the drain must be closed, when, after a few strokes of the bellows, the copper drum on the combustion chamber will rise and remain stationary if the drains are air-tight, but fall gradually, as by any opening the air finds a means of

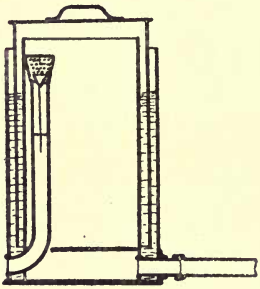

FIG. 18.

escape. With a very leaky system, it will be impossible to raise the drum at all. With a small leak, it settles down gradually, and with a rapidity proportioned to the size of the leakage. At the time of writing these lines, the apparatus has been improved upon by adding an arrangement by which the pressure applied to the drains may be regulated.

Aynsley and Rennie's smoke machine is shown in Fig. 18. It consists of an inner and an outer copper cylinder, the space between the two being filled with water. A third and inverted cylinder, with handle, acts as cover and dips

well into the water. Touch paper or oily cotton waste is burnt in the inner chamber, and the resultant smoke pumped into the drains by raising and lowering the cover. This machine is also suitable for air-testing the drains, the process being similar to that described in connection with the "Eclipse" machine.

The "Acme" and the "*Eureka*" (Fig. 19) are similar in

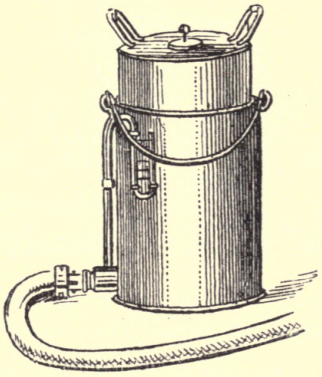

FIG. 19.

design. The latter is, however, provided with a pressure gauge for ascertaining the severity of the test applied.

PNEUMATIC MACHINE.

The "Jensen" pneumatic drain-testing machine is shown in Fig. 20. It consists of a force-pump (A), such as is used for the inflation of drain bags, by means of which air is pumped into the drains, and an attachment consisting of a pressure gauge (B) and a safety valve (C). The gauge indicates the pressure applied to the drains, whilst the

safety valve enables the Inspector to regulate the maximum pressure to be applied. Should he, for instance, desire to apply a test of 3 lb. to the square inch, the safety valve is set at that pressure. On pumping, any pressure in excess of the 3 lb. will be immediately liberated. The pump is screwed on to the cock D, the cock E being provided for

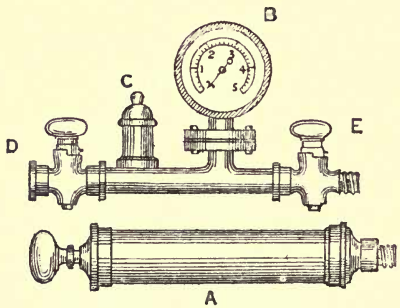

FIG. 20.

attachment to a tube passing through the plug or bag with which the drain has been stopped. When the desired pressure has been obtained, the cock D is closed, and if the drains are leaking, the reduction of pressure in the drains will be indicated on the pressure gauge.

OLFACTORY TESTS.

Banner's Grenade, which is also known as "The Drain Ferret," and is shown in Fig. 21, consists of a thin glass case, about 2in. long, containing some such liquid as oils of peppermint, assafœtida, or other strong-smelling compound. This forms the "Grenade" proper. The grenade is fixed to a hard-wood ball, 2½in. diameter, known as the "ex-

plorer," which floats the grenade through the closet trap to any given point in the soil-pipe or drain. The distance may, of course, be regulated by the string. By a sudden

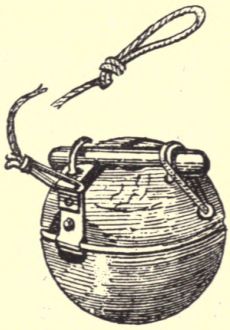

FIG. 21.

jerk of the string, a spring on the explorer is released, breaking the grenade and allowing the liquid to escape. A

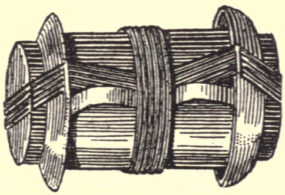

FIG. 22.

powerful smell will then be perceptible wherever leakage exists.

Burnet's Smell Tester, of which Fig. 22 is a full-size illustration, consists of a small cylinder in which is enclosed a

strong-smelling compound. The test is applied by removing the lid of the cylinder and flushing the case through a trap, after first securing the end of the string. The test is in action as soon as the string is unrolled, and gives off

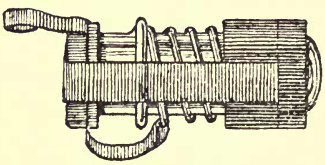

FIG. 23.

fumes whose peculiar odour make apparent any defect which may exist. A little water, say half a pint, thrown into the trap every few minutes during the time the test is

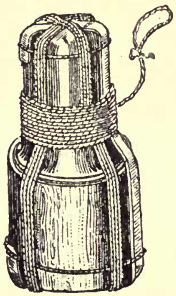

FIG. 24.

at work, will prove advantageous. The case may be withdrawn after the lapse of ten minutes.

Kemp's Tester is a small tube containing a chemical of strong odour and smoke-producing power. The tube is

closed by a cap which a spring tends to open, but which is kept in position by a strip of paper fastened to the sides of the tube. To apply the test, throw the tube into a closet trap and flush it through with a bucketful of hot water. This will soften the above-mentioned strip of paper, and the chemical compound is consequently released, making known defects by smoke and smell of great pene-

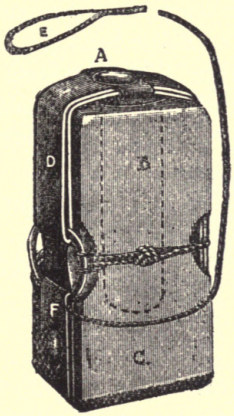

FIG. 25.

trative power. Fig. 23 is an illustration of the tester, which is about 2in. long.

Kingzett's Drain Tester (Fig. 24) is somewhat similar to Kemp's in principle. It is made in two sections, of which the narrower is of tin and hollow, and the other of wood, an air-tight joint between the two being obtained by means of an india-rubber washer. The two ends of the tester are connected by a rubber band, which tends to force the two sections apart. In this it is prevented by the string shown, which holds them

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together firmly. When the tester is thrown into the drain or soil-pipe, the string is naturally unwound, the two sections of the tester fly apart, and the chemical which is contained in the tin cylinder is liberated, thus producing a powerful odour, which will escape through any leakage which may be present in the drain.

The "Rapid" Drain Tester, shown in Fig. 25, consists of a wooden case (C), in which is inserted a glass tube (B) which contains a strong smelling compound. The case is closed by means of an elastic band (D), which is held down by a strip of paper (F). When the tester is flushed through the closet trap, this paper check is weakened, allowing the rubber band to be released. The chemical is then auto-

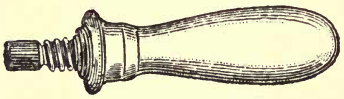

Fig. 26.

matically ejected by means of a tape (A) which dips into the glass tube. When the test is completed, the empty case may be withdrawn by means of the cord (E). The tester is 2in. long.

Hammond's Pneumatic Drain Tester (Fig. 26) consists of a small rubber bag containing smell and smoke-producing chemicals. At the mouth of the bag is fixed a screwed tube for connecting the tester with a length of rubber tubing and an air pump. The outlet of the tube is sealed by a small lead plug. When the test is to be applied, this plug is cut off, and the tester screwed to the rubber tube. It is then flushed through the trap and burst by a few strokes of the pump, when the chemicals will be immediately liberated.

By the continued use of the pump, the smoke and smell may be driven in all directions, and some measure of pressure applied to the drains and its connections. To obtain this pressure, however, all openings on the drainage system must be plugged.

Other olfactory tests are the "*Peppermint*" and "*Paraffin Oil*" tests, which will be described in a subsequent chapter

MISCELLANEOUS APPARATUS.

The "Monkey on the Stick," shown in Fig. 27, is an appliance by which otherwise inaccessible drains may be

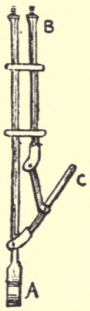

FIG. 27

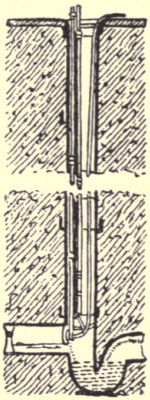

FIG. 28.

plugged. The drain bag is fixed to the clip (A) and the apparatus lowered to the drain, through the shaft of the intercepting trap, by means of drain rods. The arm (B) is then slightly lowered, by which means the spur (C) is forced out and the bag thus pressed into the drain. Inflation

may then proceed. Fig. 28 shows the apparatus applied to the drain. The "monkey" may be adapted to any size of drain by adjusting the length of the spur

Doughty's Inspection Lantern (Fig. 29).—This apparatus consists of an electric lamp on wheels, which is pushed

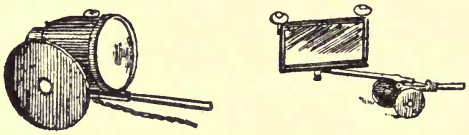

FIG. 29.

into the drain to any desired position. An automatic reflector, which is adapted to give back the light when the lantern disappears round corners, is provided, and shows up any sags, defective joints, or irregularities which may exist.

The Drain Inspection Mirror shown in Fig. 30 serves a

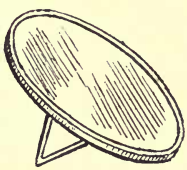

FIG. 30.

similar purpose when a light is applied to one end of a straight drain, and the mirror placed at the other.

The "Jensen" Gas Installation Testing Machine (Fig. 31) has for its object the tracing of leakages in gas pipe systems.

It consists of a container (A) in which is placed the liquid ammonia, whose fumes are pumped into the gas pipes by

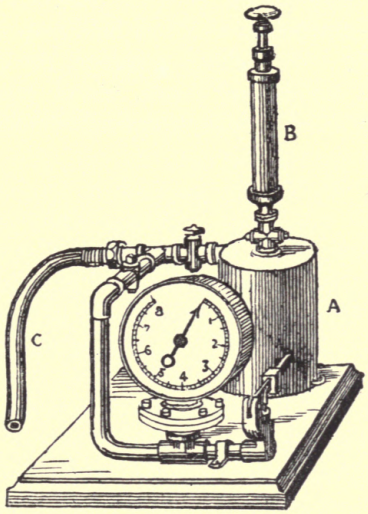

FIG. 31.

means of a small force pump (B). A pressure gauge is provided for ascertaining the severity of the test applied. C

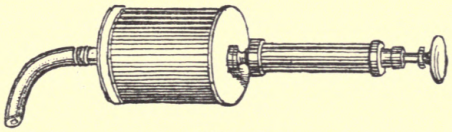

Fig. 32.

is a flexible tube for connection with the gas pipe system, and D a safety valve by which the pressure to be applied may be adjusted. The machine is about 6in high.

A modification of the same apparatus (Fig. 32), which is considerably cheaper, has also been placed upon the market, and may suffice for most tests. It consists of a pump and a container in which is held a sponge saturated with ammonia. With either apparatus the gas pipes are charged with ammoniacal fumes, whose escape (through defects) is traced by specially-prepared test papers.

CHAPTER III.

THE INSPECTION OF THE INTERIOR OF A HOUSE.

EQUIPPED with an efficient testing machine, two or three plugs or bags of the sizes most likely to be serviceable, and any other apparatus which the Inspector may deem necessary, he arrives at the house, where a plumber and a labourer await him with their tools and some puddled clay or putty. In the case of a town or small suburban house, of course, a plumber or simply a "handy" man may suffice.

After a preliminary examination of the house and its surroundings, during which instructions should be given to the labourer as to the opening up of manholes and the laying bare of drains at such points as may be necessary (see Chapter IV.), the Inspector should turn his attention to the interior of the house.

Generally speaking, it will be found most convenient to begin in the cellar or lowest floor of the house and work upwards, completing each floor in its turn until the roof has been reached. During this inspection the Inspector should be accompanied by the plumber, who must open up all casings or covers which may be fixed around fittings or over piping.

In the cellar a careful search must be made for any drain connection which might exist, all barrels and boxes being moved so that no portion of the floor may escape notice. Should a trap be found, its type must be noted, as also the depth of the "seal." It must also be noted whether

the trap contains water, whilst the point and mode of connection to the drain must be ascertained. As a rule, it will be found that such traps discharge direct into the sewage drain. This is dangerous, as foul air will gain admittance to the house should the water contained by the trap evaporate. If at all possible, traps within the house should be dispensed with, otherwise they must be led to discharge into the shafts or traps fixed outside the house, of which more later.

The materials of which the floors of the cellars are made (and this applies also to the floors of the ground floor, should there be no basement) must be examined, as it is of the utmost importance that they should be impervious. The necessity of this cannot be over-estimated, since ground-air and unwholesome effluvia, as also sewer and coal gas from leaking sewers and gas mains, may be drawn into the house by the warm air within the building. To this alone much illness is attributable, especially if the house should happen to be built on "made" ground. The lowest floors of the house should therefore always be covered with concrete and cement, asphalt, or non-porous stone slabs or tiles set in cement.

On the upper floors, the chief considerations will be water-closets, sinks, baths, and similar fittings. Of each of these a description should be made in the note-book, especially with regard to their make, condition, mode of fixing, and any other item which, in the Inspector's opinion, may be necessary. Fittings can only be described as sanitary when they are designed and constructed in such a way that the retention of filth is impossible, be it by deposit or absorption. They should also be durable, void of elaborate mechanism, and so arranged and fixed that access may be readily obtained to all parts.

Closets and slop-hoppers are carefully examined and

flushed, and a note is made of whether or not they have separate flushing cisterns. The types of the cisterns, the points at which their overflows discharge, and the quality and quantity of the flush given, are also ascertained.

Three gallons is generally the minimum quantity of water necessary to flush a closet thoroughly. This quantity is not, however, always obtainable, as many water companies

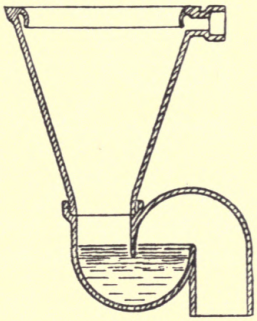

FIG. 33.

restrict the amount to two and a half or even only two gallons.

A simple, yet severe, test for ascertaining the efficiency of a closet and its water flush, is to crumple up a small piece of tissue paper and throw it into the basin. Then flush the closet, and if it is good the paper will be removed by the first flush. This is a better test than that so often shown at sanitary exhibitions, where the exhibitor will place pieces of paper all round the inside of the basin. In this test the paper is simply *forced* through the trap by the weight of the water, as it is carried to and made to cover the outlet of the basin by the first rush of water. In the other test, which I

recommend, the conditions are far more natural, as the paper will float, and can only be *flushed* out.

The closets themselves should retain a fair body of water

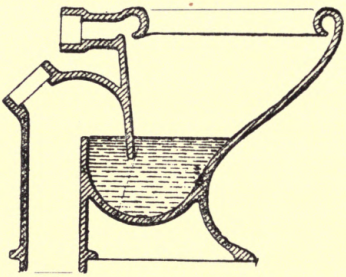

FIG. 34.

in the basin, so that fæcal matter may be immediately immersed and kept from staining the apparatus and giving off bad odours.

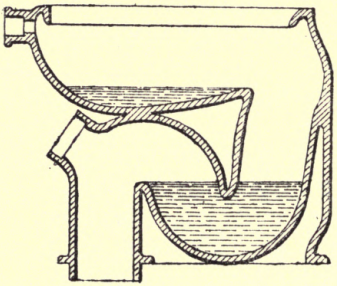

FIG. 35.

Closets of "long hopper" type (Fig. 33) do not do this, and should be condemned accordingly. Of pedestal closets, those of "wash-down" type (Fig. 34) are preferable to those

of "wash-out type (Fig. 35), which are not self-cleansing, and allow deposits to take place on the surfaces immediately above the water of the trap. This is due to the fact that all fæcal matters are discharged against these surfaces whenever the closet is flushed. Closets of "plunger" type (Fig. 36) cannot be recommended as sanitary, as the plunger and the chamber in which it is fixed are liable to become very offensive, and cannot be readily cleaned. Paper and similar matter is also liable to be caught between the plunger

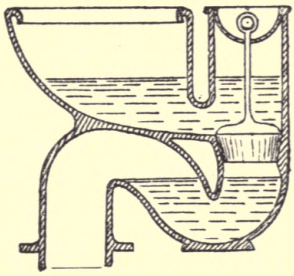

FIG. 36.

and its seating, in which case the water which should be retained in the basin will leak away.

Valve closets (Fig. 37) should be provided with overflows sufficiently large to take off the water as quickly as it enters the basin, and of such a nature that they may be readily cleaned. The overflow pipe should also be trapped. The valve box and the overflow trap must be ventilated, and some provision must be made for charging the latter with water automatically.

All "pan" closets (Fig. 38) must be condemned. Their various faults are so well known that they need no recapitulation.

All closets should discharge direct into the drains. In the case of closets fixed on the upper floors, this is done through the soil-pipe, which must be ventilated above the ridge of the roof.

Slop-hoppers should be looked upon and treated as water-closets, as they generally receive chamber slops and similar foul matter. In no case should they be treated as sinks, and led to discharge into hopper-heads or over surface traps —a practice which is rampant in the northern counties.

The floor under each closet must be examined and attention bestowed upon its condition, as also upon that of

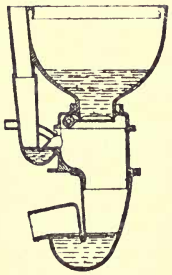

FIG. 37.

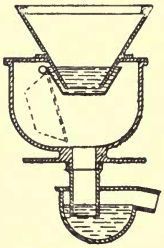

FIG. 38.

the casing, should there be one round the fitting. The floor should, of course, be of impervious materials or covered by a lead "safe," which should be turned up a few inches all round and provided with a safe pipe discharging into the open. A copper flap should be fixed on the outlet of this pipe to exclude draughts.

Any casings which may be fixed round closets should be made in such a way as to be easily removed. They must be painted or varnished on the inside, and should be smooth, as they are liable to be splashed by slops, and,

unless protected, will rot; whilst the slops themselves will give off unpleasant and unhealthy odours in decomposing.

Special attention should be paid to the materials of which sinks are made. Yorkshire and other sandstones absorb grease, soap curds, and other foul matter, and become offensive in consequence. They should therefore never be used for sinks. Glazed fire-clay, enamelled iron, and metal-lined wood sinks are better, although the lining of the latter is liable to be buckled and torn by the expansion and contraction which follow the use of hot water.

The overflows of sinks, lavatories, baths, and similar fittings must receive attention. In the majority of cases

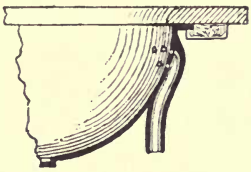

FIG. 39.

they consist simply of a few holes, in the side of the fitting, which mask the overflow pipe proper at the back (see Fig. 39). Such overflows are never flushed, and receive simply driblets from the scum on the top of the water. These congeal on the inner sides of the overflow, decompose, and give off noxious gases. Fittings supplied with these overflows should, therefore, never be commended. They should, moreover, be condemned when fixed in bedrooms or nurseries.

Better overflows are those which can be cleaned by the insertion of a brush (as in Fig. 40) and the "Loco" overflow (Fig. 41), which is self-cleansing, and *bound* to be

flushed whenever the fitting is used. The overflow pipe should, of course, always discharge into the *upper* side of the trap, as in Fig. 42.

The waste pipes of the above-mentioned fittings must also be carefully examined. Not infrequently they are

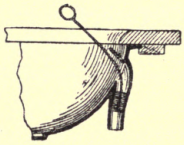

FIG. 40.

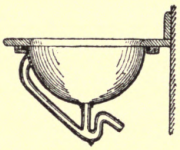

FIG. 42.

carelessly dealt with, being made to discharge into rain-water pipes, or even soil-pipes. Very often, too, they are

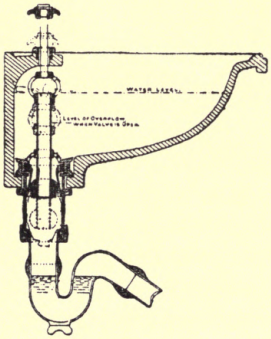

FIG. 41.

untrapped, thus leaving a free passage into the house for emanations from decomposing matter in the waste pipes. Waste pipes should, of course, always be trapped close to the outlets of the fittings by self-cleansing and efficient

traps of suitable material. The wastes, as also the traps, must further be of dimensions similar to those of the outlets from the fittings. Nothing is more absurd than a 3in. trap and waste on a 1½in. outlet, and nothing more insanitary, as they will never be properly flushed; deposits being allowed to accumulate in consequence.

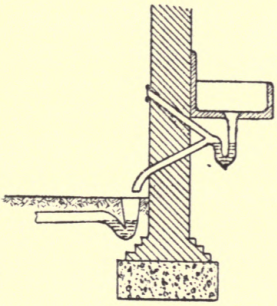

FIG. 43.

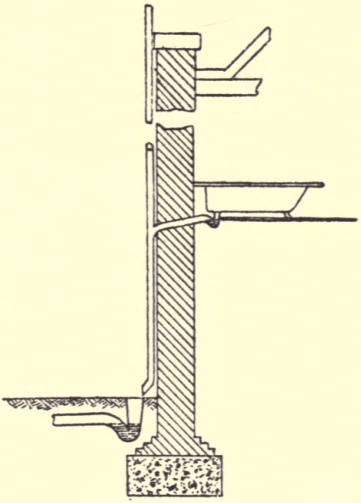

FIG. 44.

All waste pipes should discharge openly over surface traps, and must be ventilated (see Figs. 43 and 44). The practice of leading them into hopper heads, as on Fig. 45, is reprehensible, as effluvia from decomposing deposits in the latter and the piping therefrom will be readily drawn into the house through the windows.

It has already been stated that traps should be self-cleansing. This is the case only with the "syphon" traps,

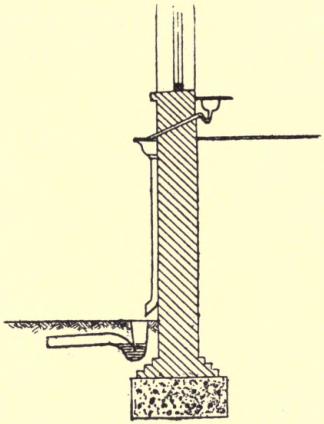

FIG. 45.

of which Figs. 46, 47, and 48 illustrate the S, P, and "running" forms. No other traps should be passed as

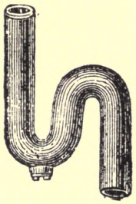

FIG. 46.

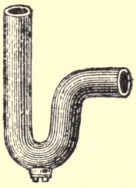

FIG. 47.

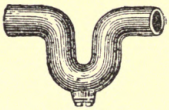

FIG. 48.

safe, as they have all some more or less pronounced fault. The D trap (Fig. 49), now happily almost extinct, is very

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uncleanly, as is also the "bell" trap (Fig. 50), which has additional disadvantages in that it provides only a very small seal, which is totally lost when the grating (to which the "bell" is attached) is removed. The "bottle" trap (Fig. 51) retains too much water, and provides abundant space for the accumulation of dirt; whilst the mechanical

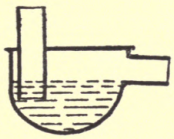

FIG. 49.

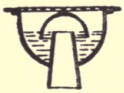

FIG. 50.

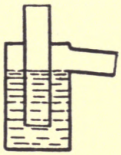

FIG. 51.

traps, of which Figs. 52, 53, and 54 illustrate the various forms, are very liable to go wrong through the adhesion of matted hair and soap curds to the valves.

All traps should be provided with screwed caps, for facilitating cleansing should they at any time require it.

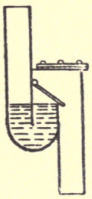

FIG. 52.

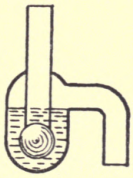

FIG. 53.

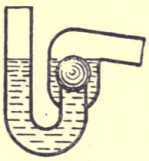

FIG. 54.

The ventilation of traps under fittings claims attention. It is desirable in all cases, and imperative when (*a*) two or more fittings discharge into the same stack-pipe, and (*b*) when the waste pipe—taken from the trap to its outlet or to its junction with the stack-pipe—is of appreciable length.

In either of these cases the traps are liable to syphonage unless ventilated. An anti-syphonage pipe should, therefore, be provided for each of the traps. When the waste pipe is comparatively short, this pipe may be simply carried to the exterior, as in Fig. 43. Otherwise it must be continued to the roof or branched into the stack pipe some distance above the level of the highest fitting, as in Figs. 55 and 56.

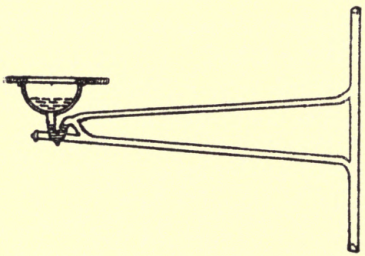

FIG. 55.

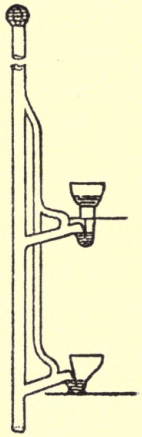

FIG. 56.

Urinals within the house should be discouraged, however good their type may be, as they are bound to become a nuisance unless frequently cleaned by hand and provided with an abundant supply of water. Nor are they necessary, as their place may be taken by the water-closets. If the householder insists upon retaining them, they must be such as will only expose a very small fouling surface. They must be flushed frequently and automatically, and should

discharge into surface traps outside. It is hardly necessary to add that each basin must be trapped separately, and that the waste pipes must be thoroughly ventilated.

All water cisterns within the house, or supplying the house, must be looked into with care, more especially so if they are used for the storage of potable water. Their condition and construction must be noted, and attention paid as to whether they are fitted with covers, to keep out dirt and vermin, and if protected against heat and frost. Cisterns which store drinking water should always be

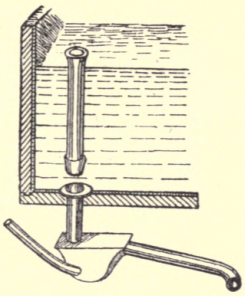

FIG. 57.

covered. They should also be placed in positions where access may be readily obtained, and where there is plenty of light and air. The best cisterns are those constructed of slate or glazed stoneware. Lead-lined and galvanised iron cisterns, on the other hand, are dangerous if the water they store is "soft." Such water dissolves and absorbs lead and zinc (with which the galvanised cisterns are coated), and the resulting compound is anything but beneficial to the human system.

As with closet cisterns, so with main cisterns, the overflows are traced, and the Inspector minutely tests which taps and fittings are supplied by each cistern. Only too frequently the same cistern is used for both drinking water and closet flushing, which only needs an overflow carried direct into the drain, or into a waste pipe, to complete the chapter of horrors. Fig. 57 shows an arrangement which is not infrequently met with in old houses. In this case the cistern overflow has been carried into a D trap (insanitary in itself), which also receives the discharge of a sink. The contents of the trap and waste are thus ventilated into the water. The overflows should, of course, discharge into the open.

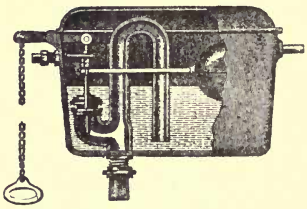

Fig. 58.

The possibility that cisterns may be found under floors must not be overlooked.

Drinking water should, of course, always be drawn direct from the main when a constant water supply is available. The cistern may, however, be retained for bath and similar water, and may even prove useful for the storage of drinking water in districts served by such water companies as are dependent upon the rainfall.

The supply pipe for the water-closet must not be taken off main storage cisterns direct, but a smaller cistern (water-waste preventer—Fig. 58) must be interposed.

Great care must be taken to ascertain if any possible source of pollution to drinking water exists, as this, of all things, should be above suspicion. If the Inspector, therefore, finds but the slightest cause by which the water supply might be tainted—be it in the mains, cisterns, or well—a full investigation must be made, and a sample of the water taken for analysis by a competent analytical chemist. For this purpose I append the following directions, which will prove useful :—

1. Use clean, stoppered, glass bottles, preferably those of the size known as "Winchester Quarts," which may be obtained of any chemist.

2. If the sample is taken from a tap or pump, allow a quantity to run away before filling the bottle, unless it is desirable to show the water at its worst.

3. If the sample is to be collected from a well or tank, plunge the bottle well under the water so as to avoid surface water. Any deposits that may be at the bottom must also be avoided.

4. In all cases rinse the bottle several times with the water to be analysed, then fill to the neck and tie down the stopper.

5. When sending water for analysis, the source should be stated—whether from the mains, cistern, deep or shallow well, or spring. It is also necessary to give particulars of any likely source of pollution, and, with well water, the nature of the soil through which the water has passed. The materials with which the water has been in contact should also be stated.

Any filters which may be in use in the house must be carefully examined, as they generally do far more harm

than good, and actually pollute the water sought to be purified.

This happens if the construction of the filters and their "mediums" is such as to favour putrefaction and the growth of low forms of life, which is the case with all carbon, spongy iron, and kindred filters. The only filters

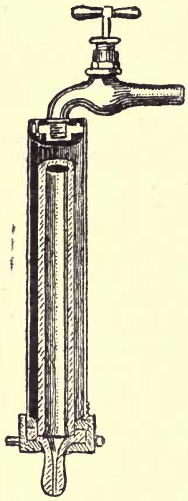

FIG. 59.

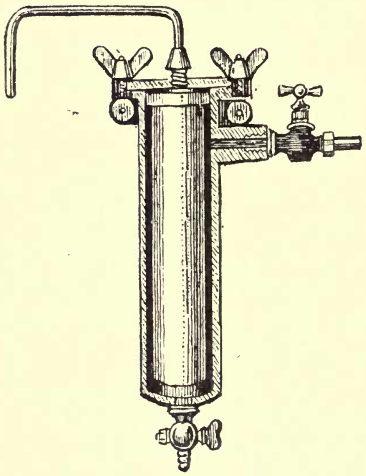

FIG. 60.

which can be recommended as safe are the "Chamberland Pasteur" (Fig. 59), "Nordmeyer-Berkefeld" (Fig. 60), and "Aéri-Filtre-Mallié" (Fig. 61) filters,* which are all of the type known as "Candle filters." These filters do not allow the passage of micro-organisms, and do not impart

* Figs. 59, 60, and 61 show the *pressure* form of the filters which they represent.

any harmful substance to the water. The "Chamberland-Pasteur" filter is considered the best. All three filters require frequent and thorough cleaning to remain efficient.

It need hardly be said that the filtered water must be carefully guarded against pollution.

Another danger which the Inspector must not lose sight of, is that (unfortunately) common to almost all gas-lit houses. I refer to defective gas-piping and gas-fittings.

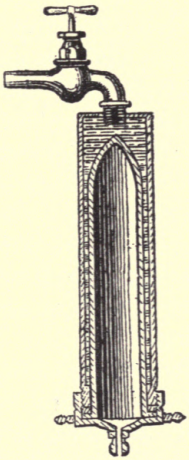

FIG. 61.

Although the escape of gas may be minute, and even unnoticeable to the sense of smell, it is nevertheless dangerous, as the constant and insidious inhaling of coal gas leads to both acute and chronic poisoning. This danger, which has always been great, and to which attention has been drawn from time to time, is now greatly magnified

since water gas has been freely introduced into the gas mains of most of our chief cities. Water gas, as is well known, consists largely of carbon-monoxide, which is one of the most dangerous and poisonous gases known.

The circumstances make it essential that all systems of gas-pipes should be examined, tested, and proved sound in the same way as the drainage system.

To do this, connect the gas-pipe testing machine (Fig. 31), described in the foregoing chapter, to one of the gas brackets by means of the flexible tube. Then, after closing all cocks on the system (including that from the meter), pump into the gas-pipes until the pressure gauge registers the pressure to which the pipes are to be tested. If the indicator falls, a leakage exists and must be traced.

For this purpose pour a small quantity of liquid ammonia (consistent with the size of the gas-pipe system) into the container of the machine, and continue to pump until the gas-pipes are thoroughly charged with the ammonia fumes. Then pass a test paper along, or as near as possible to, the gas-pipes, and wherever there is an escape the colour of the test paper will be changed.

The quantity of ammonia required for an ordinary test is from half an ounce to one ounce.

When applying the ammonia test it will be found advantageous to open the tap of the gas bracket furthest from the machine, until the air contained by the pipes has been expelled and replaced by ammoniacal fumes. This ensures the pipes being thoroughly charged. If pumping is continued after re-closing this tap, and there should be leakages, the ammonia fumes will be forced through plaster and such other covers as may be over the pipes, and through any other crevice through which gas might escape.

Every gas-pipe system should withstand a pressure of at

least one or two pounds per square inch, which, although small, will allow a good margin of safety. The greater the pressure withstood, however, the better, as the chances of leakage are reduced in proportion.

CHAPTER IV.

THE INSPECTION OF THE EXTERIOR OF A HOUSE.

WHILST the Inspector has been engaged with the interior of the house, the labourer has been busy opening up the ground outside and exposing the drains at the foot of each soil-pipe, at some point a few yards from the house, and in any other spot which the Inspector may have deemed necessary. He is now left to assist the plumber in providing access to any manholes which may exist, and to the tops of all ventilation pipes. If the Inspector is so fortunate as to find someone who "knows all about the drains," his services are enlisted to give a clue as to the course of the drains and their construction. Experience, however, has taught that seeing is believing, and the Inspector tries to find evidence for himself in support of his informant's statements. These, and the plan of the drains often found at the house, should, in fact, only serve to give the "information received" on which detectives act. A Sanitary Inspector is nothing if not a detective, and he may be grievously misled if he trusts to anyone but himself. How, then, should he look for proof? One way is to remove the grating from each gully, and, utilising the labourer's arm as a cat's-paw, find the direction in which the gully discharges. Another way is to examine the ground minutely where the drain is supposed to cross a lawn or field. In this case, even many years after the drain has been laid, the turf will show unmistakeable marks

by which the course may be traced with the utmost accuracy.

If the drain is faulty its course may also be traced minutely by the smoke test, as the smoke, under favourable circumstances, will find its way up through the ground. I have known it to penetrate 10ft. of earth, and in many cases concrete and asphalt. This mode of tracing the course will be facilitated by piercing the ground along the supposed line of drain with the probing iron shown in Fig. 62. When this is done, the escaping smoke will readily find its way up through the holes made.

Fig. 62.

Should the above signs fail, and it is necessary to ascertain the exact course of the drains, nothing remains but to lay bare the pipes at various points, or to ascertain their position by probing. I may here point out that if the point of the probing-rod is notched, as in Fig. 63, it will also be useful for ascertaining the nature of the ground at any given depth, as, with a little manipulation, some of the soil will be retained in the notch. A rod, from one-half to three-quarters of an inch in diameter, made like a cheese-taster, will also prove useful for this purpose.

Fig. 63.

Should it be a case of tracing the discharge of one drain into another, a pipe must be taken out of the latter if no opening—such as a manhole—exists; and coloured water (coloured by lime, whiting, or anything else near at hand) poured down the former. If colouring matter cannot be obtained, small pieces of cork or cork-dust may be substi-

tuted. The latter may be bought in various colours for this purpose.

When the course of the drain has been traced, the

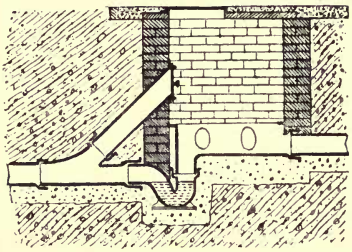

FIG. 64.

Inspector must ascertain if the drains are provided with an intercepting trap at their outfall. This is difficult if the trap is not fixed in an inspection chamber or otherwise

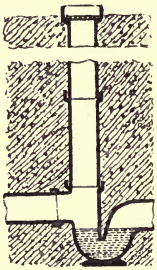

FIG. 65.

visible, and can only be assumed in accordance with the result of the smoke test, of which more later. The intercepting trap should, however, *always* be accessible, and if

the Inspector cannot find it, he must, in his report, recommend that the drain be opened up at its outfall. If a trap is then found, it should have an inspection chamber built round it, as in Fig. 64. Should none be traceable, then one must be inserted. If the cost of the chamber is

FIG. 66.

FIG. 67.

objected to, then the trap shaft must at least be carried up to the surface of the ground, as in Fig. 65.

Intercepting—as all other traps—must be self-cleansing, and such as will provide an efficient "seal" with a minimum quantity of water, so that the latter will be frequently

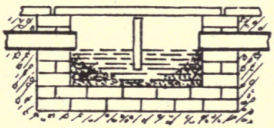

FIG. 68.

changed and not become stagnant. There should be a distinct drop from the invert of the drain to the water-level, in order to form a cascade, which will have a great tendency to keep the trap clean. The "running syphons," shown in Figs. 66 and 67, are not provided with such a drop, and the flow through them is consequently very sluggish. These traps are not self-cleansing, and must therefore be condemned. The "Dipstone" trap, shown in Fig. 68, which

is sometimes met with, is, it need hardly be said, also a bad form of trap.

If the disconnecting trap, or chamber (see Fig. 64), is provided with a sweeping eye for access to the drain between the trap and the sewer, it must be seen to that the eye cover is air-tight, and such as will preclude the passage of sewer gas.

The Inspector must next devote his attention to the construction of the drains, and note their sizes, condition,

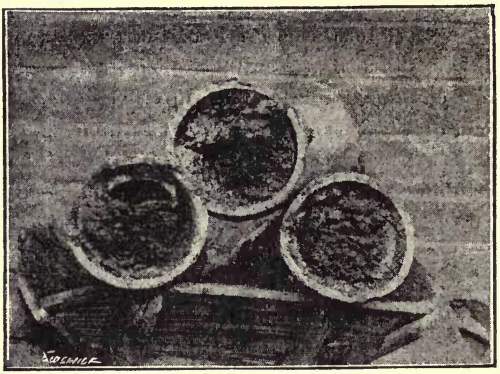

FIG. 69.—CHOKED DRAIN PIPES.

materials, and arrangement, which are not always what they should be. Figs. 69-72, and the Frontispiece, which are reproduced from *The Sanitary Record* through the courtesy of its editor, illustrate the state of affairs which may be found.

The materials made use of may be stoneware or iron (either of them glazed or rough inside) or brickwork. Sometimes two or even all three of these materials may

have been used. In a London town-house I thus found the head of the drain to consist of 6in. stoneware pipes, and the central portion of an old 18in. brick barrel, whilst

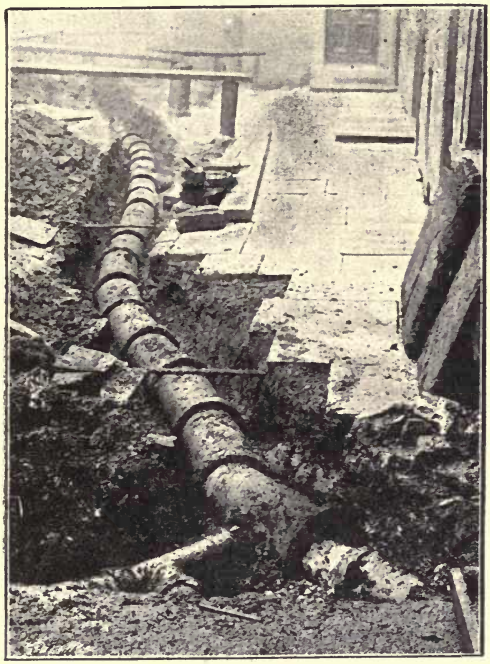

FIG. 70.

Defective Drains, showing also faulty connections of 4in. branch drains to 6in. main drain.

the connection to the sewer had been made with a 4in. stoneware pipe drain. Nor is it uncommon to find brick and stone drains, which are generally square, and have

their tops and bottoms formed of stone slabs, and their sides constructed of brickwork. Large brick culverts,

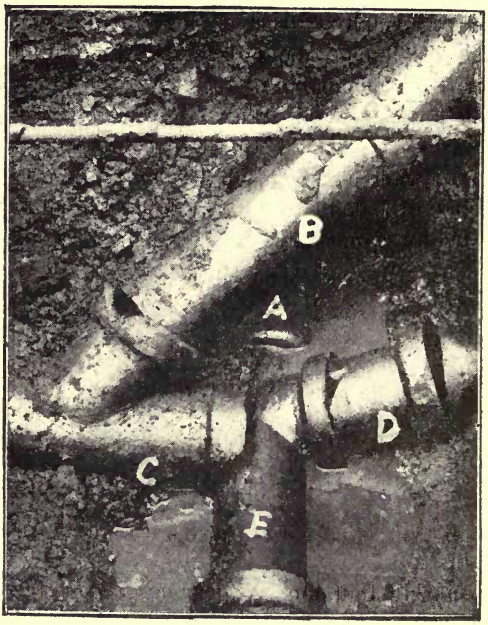

FIG. 71.

Faulty junctions of drains rom eight houses (A, main drain from four houses ; B, branch drain from surface trap ; C, main drain from two houses on left ; D, main drain from two houses on right ; E, main drain to public sewer.

sometimes as much as 4ft. or 5ft. high (where a 4in. or 6in. pipe drain would suffice !) may also be met with.

If pipes have been used, they may be found to be "firsts,

"seconds," or "thirds"—all but the "firsts," of course, amounting to "rubbish." They may be laid on or encased in concrete; or, in the case of iron pipes, may be fixed on

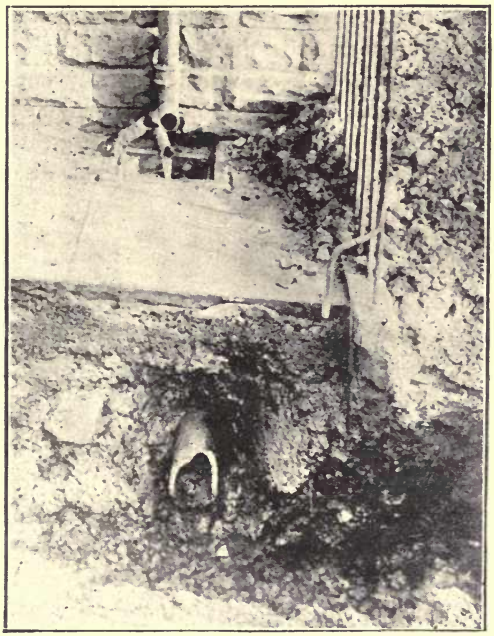

FIG. 72.

Defective Drains, showing discharges from scullery sink flowing into foundations of house.

walls or under ceilings, should the basement floor be at a lower level than the sewer. All this must be noted.

The jointing, too, must be carefully examined, as it is

frequently found to be insufficiently or carelessly done. This is especially the case with stoneware drains.

It would, of course, be too much of an undertaking to examine each and every joint. A few here and there can, however, always be bared, and they will generally give a good idea as to the rest. To assume that the jointing is good because it withstands the test applied, is erroneous. Take, for instance, a joint which originally consisted of gaskin and cement. Although this joint may be sound to a moderate test, it will be found that in the great majority of cases the gaskin has decomposed and entirely disappeared,

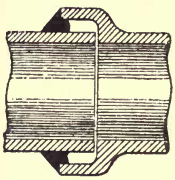

FIG. 73.

FIG. 74.

leaving a considerable space for the accumulation of sewage at each joint (see Fig. 73). That, of course, is not sanitary.

Other faulty joints which may be found, and which may even withstand a smoke-test, are the ordinary clay joint, and the clay joint masked by a thin coat of cement. Such is the nature of clay, that drains so jointed may be condemned without taking the trouble of applying a test, however sound and newly-made the joints may be. The clay is, of course, liable to be washed out of the sockets by the flow within the drain, and to be perforated by worms and tree roots, which latter block up the drains. And here I

may point out that the very presence of roots in a drain is evidence of leakage.

Nor are cement joints always what they should be, although good cement, properly used, is undoubtedly the best jointing material for stoneware drains. We have already seen one bad cement joint in Fig. 73; Fig. 74 illustrates another. A third is the joint which, though perhaps perfect in other respects, has not been cleaned off from the interior of the drain. Such a joint (Fig. 75) allows a ridge of cement to protrude in the drain, which will obstruct the free flow of sewage and accumulate dirt. This

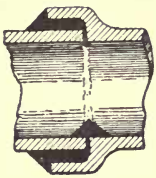

FIG. 75.

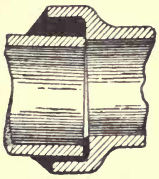

FIG. 76.

latter will also occur if (as in Fig. 76) the drain pipes are not concentric.

All such items must receive careful attention at the hands of the Inspector, his task being facilitated by a judicious use of Doughty's inspection lantern (Fig. 29), or the ordinary and more compact mirror (Fig. 30), where such can be utilised.

Examine the connection of each soil and ventilation pipe with the drain. This is, more often than not, a weak point in the drainage system, owing to the difficulty of making a thorough joint between the metal piping and the stoneware drain. In addition to this, however, the soil-pipe

may be merely inserted into a hole in the crown of the drain and jointed anyhow—with paper even, as I have found. A 4in. soil-pipe may also have been carried into the socket of a 6in. drain pipe, or not been connected to the drain at all. The connection of the soil-pipe, in short, is usually the weakest link in the chain on which the life of an innocent may depend.

View with suspicion any tree which may be near the course of the drains, and have the ground opened near it, for a serious defect may be found there. I remember inspecting a country house where the outfall drain, laid but

Fig. 77.

Fig. 78

a few years previously, had been carried across a field. The contractor had been anxious that the course of the drain should be marked, and had devised the bright scheme of planting a row of trees along it. The result was the usual, for the trees had grown and their roots had found their way round and into the drain, and had jumbled up the pipes indiscriminately.

A few junctions and bends should be bared, if they can be localised. Right-angled junctions (Fig. 77) and sharp bends (Fig. 78) retard the flow in drains and invite stoppages, and should be noted accordingly; whilst sometimes "junctions" are found where the spigot end of a pipe has

been merely inserted into a hole in the side of the main drain. Bends made of straight pipes, as in Fig. 79, may also be found. In these "bends" objectionable angles are formed at the junctions of the pipes, and these will tend to accumulate sewage matter. The joints must necessarily also be imperfect.

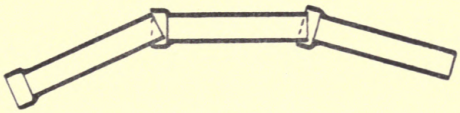

FIG. 79.

If inspection chambers are provided, as they should be on all important bends and junctions, attention must be bestowed upon their condition and construction. Their interior surfaces must be made with, or covered by, impervious materials, such as glazed bricks set in cement. If ordinary bricks, stones, or concrete are used, the interior

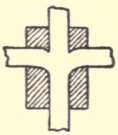

FIG. 81.

FIG. 80.

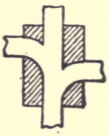

FIG. 82.

must be rendered in cement to a smooth surface. The manholes must be covered with air-tight and easily removable covers.

Branch drains discharging into the manholes must be led into their outlet drains by means of properly-formed channels of easy curve. Such channels must, of course, discharge in

the direction of the flow through the manhole, and must, if necessary, be curved up (as in Fig. 80) on their outer side to prevent splashing. If there are branches on both sides of the manhole, they should not face each other (as in Fig. 81), otherwise the sewage discharged by one branch

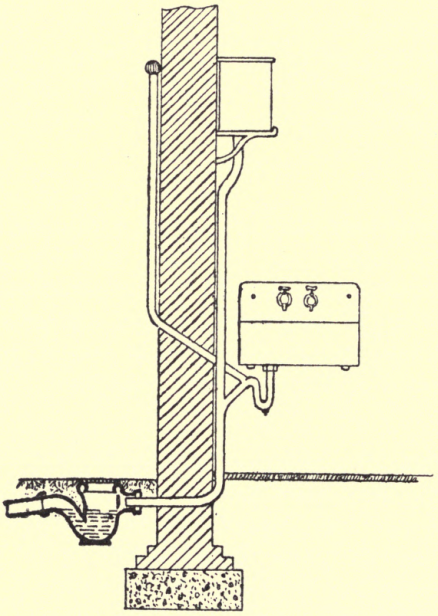

Fig. 83.

will wash up the one opposite. Fig. 82 shows how the branches should be arranged to avoid this.

Having disposed of the drains, the Inspector must turn his attention to the grease-traps and gullies. Generally speaking, the former are very doubtful advantages. In the

first place, they are usually very difficult to keep clean ; and, if they can be kept clean, they are almost always neglected. Anything which is dependent upon human hands for cleanliness is always better left out from the drainage system.

Grease-traps are generally fixed under the scullery sink wastes, to retain the grease discharged by the latter, and thus prevent it from choking the drains. This may, however, also be done in a cleanlier way by leading the sink waste into a flushing-rim gully, and flushing it by an automatic flushing tank, as in Fig. 83. By this means the grease is broken up and flushed through the drain, without chance of adhesion, as the fragments are cold. When this

FIG. 84.

FIG. 85.

FIG. 86.

is done, it is imperative to ventilate the waste pipe (as shown), otherwise the trap under the sink will be syphoned by the discharge of the tank. If the flushing tank is not convenient, or too expensive, the bath waste can be substituted, if carried into the rim of the gully direct.

The type of each grease and gully trap must be ascertained, and a note made of whether it is self-cleansing or such as to retain filth. Attention must also be paid to the depth of the "seal," and the setting of the trap, which not infrequently is such that any "seal" which may have been intended for it has been lost through the trap leaning on its side, as in Fig. 84.

The only self-cleansing traps are those of "syphon" type (Figs. 85 and 86), of which there is an infinite variety.

"Cesspool" traps (Fig. 87) and "box' traps (Fig. 88, retain dirt, and must be condemned accordingly. The defects of the "Bell" trap (Fig. 89) and the "Lip" trap (Fig. 90) are so well known and recognised as to need no recapitulation. They are still to be met with, however, and

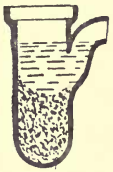

FIG. 87.

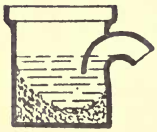

FIG. 88.

are generally found fixed over square brick or stone chambers, as shown in the illustrations.

The position of each gully must also be examined, so as to ascertain whether any trap is liable to be unsealed by evaporation, without a chance of being re-filled automatically.

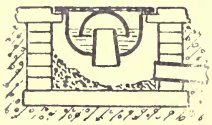

FIG. 89.

FIG. 90.

If any such is found, it should be noted, in order that a recommendation may be subsequently made for its discharge over a better situated trap. In Fig. 91 one trap is fixed under a roof, and cannot be re-filled by any waste pipe, or even by rain. It has therefore been made to discharge into the other trap, which also receives a waste pipe.

The Inspector must now turn his attention to each rain-water pipe, soil-pipe, and inlet and outlet ventilator.

As to the rain-water pipes, make a note of whether they discharge into a rain-water tank, over surface traps, into sunk traps, or direct into the drain. If they discharge into either of the two latter, then, of course, that is a defect. Should a rain-water tank exist, its position, size, and construction, together with the nature and point of its overflow, must be ascertained. The condition of the rain-water pipes must also be noted, as they are frequently cracked by frost or choked with rust. Not infrequently they are made use

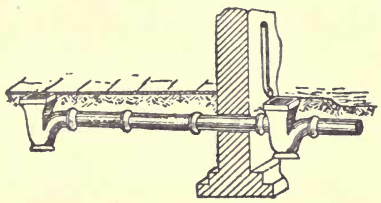

FIG. 91.

of as soil-pipes or drain ventilators, which is, of course, a grave defect—unless they serve as ventilators to rain-water drains, in which case their joints must be well made. Their upper extremities should in that case also be well out of the way of all windows.

With regard to the soil-pipes and ventilation pipes, their sizes, construction, condition, and jointing, must be carefully examined and noted. The thickness of the piping and —in the case of iron pipes—the width and depth of the sockets must also be ascertained. A note must also be made of the means by which the pipes are fixed, whether or not they are carried up full bore, and the height at which

they terminate. Nor will it be amiss to pay some attention to the windows and chimneys close to which the pipes may pass.

Outlet-ventilation pipes should always be branched out from the crown of the drain (as in Fig. 92), and should be

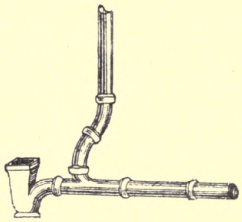

FIG. 92.

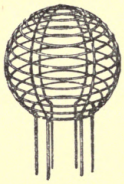

FIG. 93.

fixed on the extremities of all long branch drains. Their outlets should be protected by copper wire guards (Fig. 93). Cowls should never be used, as they provide convenient

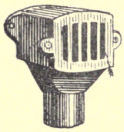

FIG. 94.

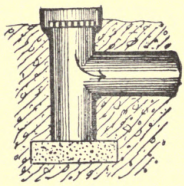

FIG. 95.

shelter for birds' nests, which put an effectual stop to ventilation.

The air-inlet pipe should be branched into the extremity of the drain furthest from the outlet ventilator. This is usually at the disconnecting trap. If near the house, the

inlet may be fitted with a mica flap valve (Fig. 94); if some distance off, a copper wire guard or a grating (as in Fig. 95) is better, as the flap valves are very liable to get out of order unless frequently looked after.

When all matters appertaining to the drainage system have been disposed of, the Inspector must turn his attention to the sewage outlet.

In a town house it may be taken for granted that the drains connect into the main sewer, and it will only be

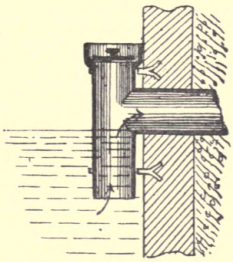

FIG. 96.

necessary to ascertain and note its position. In the case of a country house it must, however, be traced.

Elaborate sewage works may exist, and should be carefully examined and tested. The sewage outlet may also be into a cesspool, whose position in relation to the house must be considered and noted, together with its size and construction. The tank should be air and water-tight, and provision made at its outlet for the retention of solids. This is most conveniently carried out by the junction-pipe shown in Fig. 96. Under these conditions the cesspool need never be cleaned out, as the solids will be disintegrated and partly purified by the action of micro-organisms.

The "Septic tank," which has lately caused so much stir in sanitary circles, is, in fact, nothing more nor less than an air-tight, and, to some extent, modified cesspool.

From the cesspool, or sewage works, the overflow may be found to discharge into a brook or river, openly on a field, or into irrigation channels, or pipes. Wherever it goes to, its discharge must be traced, and notes made as to the condition of the effluent, and whether this is likely to become a nuisance.

Privies and ashpits should receive attention. The former should always be condemned if they are not absolutely necessary, as they cannot be but harmful to health, unless carefully looked after. If they must be retained, they should be at some distance from the house. They should be thoroughly ventilated and kept as small as possible, and must be frequently emptied, cleaned, and disinfected. Some dry ashes or earth should be thrown on the excreta whenever the privy is used.

Ashpits, or dust-bins, should not be in aërial communication with the house. Neither ought they to be built against the walls of the house, as emanations and soakage from them would find their way into the building. They should be covered by a sloping roof, so that the rain may run off, as they are very liable to become a nuisance if rain-water is allowed to mix with the refuse matter which they contain.

If the water supply of the house is derived from a well, the latter must be opened and inspected in order to ascertain whether there is any evidence of pollution above the water level. If such be the case, the brickwork will be discoloured at one point or another, in a manner which, if once seen, will never be mistaken. The position of the well in relation to the house and any likely source of pollution,

must also be carefully considered. The nature of the well—if "shallow" or "deep"—must also be ascertained.*

If the well is a "deep" well, care must be taken to ascertain if any subsoil water gains admittance to the well, as this often proves a serious source of pollution.

Before leaving the house it will be well to make inquiries as to whether the drains are ever cleaned or looked after. If they are, it must be ascertained by whom the work is done, how frequently, and in what manner. Not unfrequently it is undertaken by some person who is totally unfit for the work, both in skill and intelligence. I have thus found the work entrusted to some old gardener, who, no doubt meaning well, used to mop up every drop of water contained by traps. And this, of all places, in a large hospital! In this case it was the only "defect" I could find, but it was quite sufficient to account for all the mal-odours complained of, and for the aggravation of the many "cases" which would have been speedily cured in a healthier atmosphere.

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* The terms "shallow" and "deep" do not apply to the actual depth of the well—a "shallow well" being often deeper than a "deep well." A "shallow well" is a well which taps the subsoil water; a

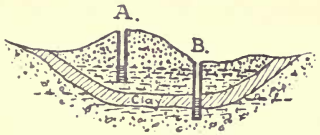

FIG. 97.

"deep well" one which pierces the impervious stratum upon which the subsoil water is superposed, and which taps the water beneath it—the deep water. In Fig. 97 A is a "shallow," and B a "deep" well.

CHAPTER V.

TESTING.

THE particulars now collected, will, in the majority of cases, allow the Inspector to form an opinion as to the sanitary condition, or otherwise, of the premises under consideration. Should he be convinced that the drains are of an unsatisfactory character, they will suffice to condemn the drains, and no tests need be applied, as it will be of little use to know that the drains are air-tight should their general

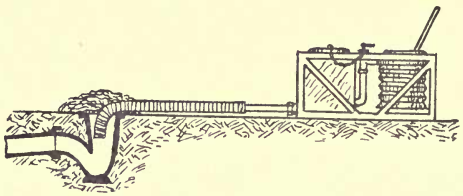

FIG. 98.

arrangement and construction be unsatisfactory. Very bad drains, moreover, cannot be tested. Smoke or water may be applied, it is true, but the process cannot be termed "testing," and will only waste time.

Should the Inspector, on the other hand, be satisfied with the main features of the drains, he applies a smoke test with one or other of the machines described in the first chapter. If the test can be applied through a manhole, so much the better; if not, then a gully-trap must be unsealed

—*i.e.*, emptied—at some suitable point in the middle of the drains, or section of drains, for they should be tested in sections if extensive. The nozzle from the smoke-machine is then inserted, and the space round it made up with puddled clay or putty (as in Fig. 98), unless the opening is such as to allow of the use of a drain plug. During a long practice, however, I have seldom been able to do this when inspecting old drains, and as a rule recourse must be had to the clay or putty.

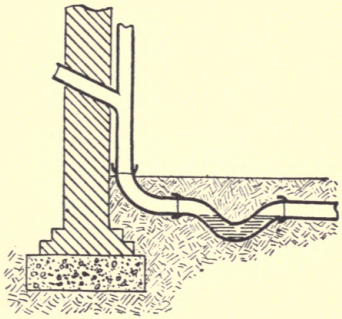

FIG. 99.

If the house is inhabited, directions must be given to disuse all the fittings which discharge into the gully in use, otherwise the trap will be re-charged and the test interfered with. Indeed, if avoidable, no fitting whatever should be used, as the admission of water to the drains tends to condense the smoke and retards or prejudices a fair test.

Having fired the machine and commenced pumping, each opening on the drainage system is closed as smoke issues. Not before, however, as it is advisable to expel all air from

the drains; whilst the free issue of smoke will indicate that no stoppage exists in the drains or the ventilation pipes. Should no smoke appear at some expected point, such as a soil-pipe or other ventilator, the cause must be ascertained. It will usually be found that this is due either to a sunk trap (proper—Fig. 99, or formed by a depression in the drain—Fig. 100) or there may be a stoppage, which must be removed if possible. In ventilation pipes, for instance, it is not uncommon to find birds' nests. These are sometimes within reach, and can be removed by hand or with the aid

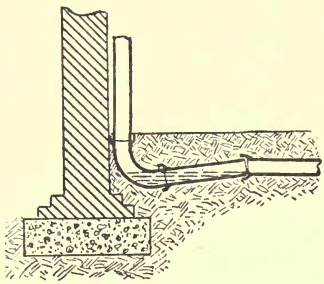

FIG. 100.

of a stick with a hook at its end. At other times, especially when the nests are old, they may have fallen to some depth in the pipe. The best thing to do in that case is to force them down into and through the drains by a copious supply of water. Oxide of iron, or rust, is also a frequent cause of stoppage in iron ventilation pipes, especially so if the interior surfaces of the piping are not protected by an anti-corrosive coating. In this case the stoppage will usually be found at bends (as in Fig. 101), the rust having fallen from above and gradually collected at those points.

It is always an easy matter to ascertain whether it is the ventilation pipe or the drain which is blocked. All that need be done is to place the ear to the pipe whilst the assistant pours a little water into the ventilation pipe through its top. By the same means one is usually also able to judge as to the position and nature of the obstruction.

Should no stoppage exist and a down-draught be found in ventilation pipes, it may be taken for granted that extensive leakages exist in the drains, or that the drains are untrapped from the sewer. In the latter case the only course open to

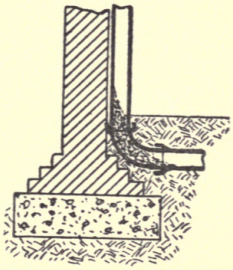

FIG. 101.

the Inspector is to open up the drain where it leaves the premises and stop up the end. If that is not practicable, he must abandon the test until such alterations as he may suggest have been commenced and a trap has been inserted.

If all goes well, the pumping is continued for some time after all the outlets have been closed, and the Inspector walks over the course of the drains in search of escaping smoke. Soil-pipes and ventilation pipes and their joints are examined for the same purpose, as are also all sanitary

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fittings and rooms within the house. *All* rooms should be examined, whether they be near to or far from the drains and their appurtenances. It is generally the unexpected which happens, and the Inspector may often find an escape of smoke where he least expects it. In testing the drains of the house shown in Fig. 102, for instance, I was surprised to find smoke in the drawing-room, situated on the ground floor of the house, at the corner marked A. For some time

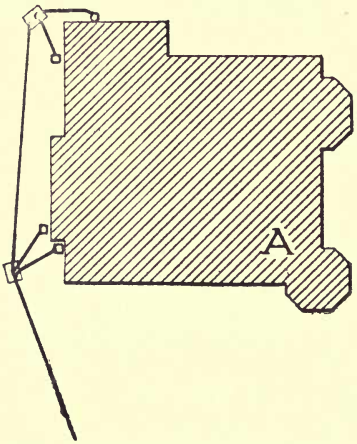


FIG. 102.

the matter was inexplicable, there being neither drains waste pipes, nor fittings anywhere near the room, and no distinct stream of smoke to give a clue. Eventually, however, I found a slight trace of smoke in the basement, and further investigation proved the existence of an old land drain under the house. The sewage drain was leaking at the lower manhole, and part of the smoke which escaped at that point found its way into the land drain. The warm

air in the house drew it through the latter and into a hollow wall, whence it eventually found its way into the drawing-room. As the smoke found its way into the house then, so did formerly drain air, and it was little wonder that the inmates had from time to time suffered.

Although smoke tests are sometimes applied to the drains through closets, sinks, and other fittings within the house, the practice is not commendable, as the smoke and smell will find their way through the building, however well the doors may be closed. Should it do this, it is, of course, obvious that the Inspector will be misled. The tests should therefore always be applied *outside* the house, and as far away from windows and doors as possible. In exceptional cases it may be found necessary to apply the test from the roof through one of the ventilation pipes. Doors and windows should in all cases be closed before the smoke-machine is lighted.

It should be stated that the smoke-machine must in all cases be pumped very slowly and regularly. If worked too fast, the cotton waste or tobacco cloth will be made to *blaze* instead of to *smoulder*, and then little or no smoke will be produced. The machine will also suffer, as it will be overheated and in time burnt through.

Before applying a smoke test, it will be well to ascertain that the drains are not charged with coal gas. This happens at times through leaking gas mains in the vicinity of the drains, and if the latter are not properly ventilated, there may be a sufficient accumulation of gas to cause a serious explosion through sparks from the smoke machine. Should, therefore, gas be perceived when opening a manhole or unsealing a trap, the drain must be ventilated before the smoke test is applied. This is best done by pumping for some little while with the empty smoke machine, after first

opening the manholes or unsealing a few traps, should the drains not be provided with ventilation shafts.

With smoke-rockets, there is another danger owing to the sulphurous gases given off during their combustion. If these are inhaled, they may cause insensibility, and eventually suffocation. Details of such an occurrence are given in the report (dated January 4th, 1899) of the Oxford Sanitary Committee to their Town Council. From these it appears that the gases given off by the smoke-rockets were retained in the lower part of a manhole owing to the dense condition of the atmosphere. The man who had applied, and subsequently withdrawn, the rockets, was overpowered by the fumes in the manhole, and rendered unconscious in consequence, as was also his would-be rescuer. Both men were eventually got out and animation restored, although one of the men remained unconscious for twelve hours.

Such an occurrence may, however, easily be avoided by the exercise of care.

All results of the smoke test must be noted, be they positive or negative, especial attention being, of course, bestowed upon such defects as may be disclosed.

The absence of escaping smoke must not, however, be taken as absolute proof of the soundness of underground drains, as smoke is readily condensed by damp ground. Very firm ground or good asphalt or cement paving may also prevent its free issue. With the majority of smoke machines, moreover, no definite pressure is brought to bear on the inside of the drains. In the case of hidden pipes, therefore, the smoke test only gives negative proof of soundness, and, although the drains may appear to be perfect, all that can really be said is that nothing wrong has been disclosed.

Should the drains, therefore, have withstood the smoke

test, a "hydraulic," or water test, which is more severe and more telling, should be applied. This is done by plugging the outlet of the drain (as in Fig. 103) with one or other of the plugs or bags described in Chapter I. Personally, I prefer bags, as they adapt themselves better to the shape of the drain, which is not always regular. The drain is then filled with water to the level of the highest gully*, and allowed to remain charged for the space of at least half an hour. If during this time the water level remains stationary, the drains may be passed as sound. If, on

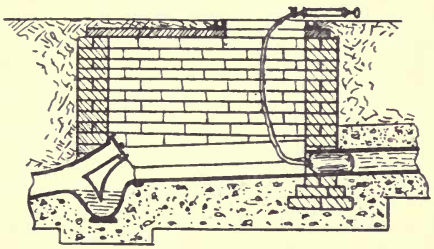


Fig. 103

the other hand, it falls, then a leakage exists. The amount of the leakage may, of course, be roughly ascertained by noting the quantity of water which disappears in a given time, and this will often also give a clue as to whether the whole drain or only part thereof is faulty. If the leakage is considerable, for instance, it will be generally found that the whole of the drain is leaking. If, on the other hand, the loss of water is but slight, although constant,

* It sometimes happens that one or two gullies are at a considerably lower level than the rest. In that case it is necessary to plug their mouths so that the drain may be charged to the level of the higher gullies.

the drain may only be leaking at one or two points, which should be located if possible.

This is done by testing the drains in sections. Take, for instance, the case of the house shown in Fig. 104. It is assumed that Sections I. and II. have been tested separately by plugging the two inlet drains to the inspection chamber A, and that whereas Section I. has been found sound, a slight leakage has been proved to exist in Section II. To

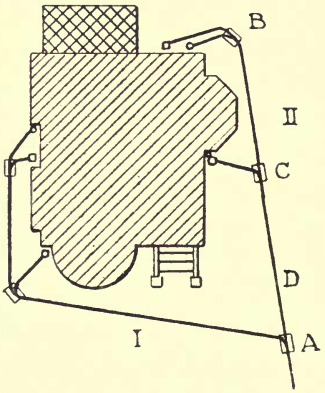


Fig. 104.

locate this leakage, the two drains discharging into chamber B are plugged and tested. Should they be sound, the drains which enter the chamber C are tested, and lastly, the drain between C and A. This will have revealed the portion of drain which is faulty. We will assume that it is the drain C—A. The "Eclipse" bag (Fig. 11, Chapter I.) is now called into requisition, and this drain tested in short lengths, in the manner described in Chapter I., until the exact point of leakage has been found at, say, D.

The value of being able to say precisely where the leakage is, will be apparent. Instead of having to open up the ground from A to B, or even only from A to C, to find and repair the leakage, a comparatively small hole at D only need be made.

The object of testing from the head of the drain downwards is to economise time and water, the water used for testing the upper sections being again used in the lower portions. Care must be taken, however, to release the water gradually, as a sudden rush might force out the plug used in the lower section of the drain.

When filling the drains, it is a good plan to unseal the gully traps, so that the air contained by the drains may be expelled. If this is not done, the air, which is gradually compressed, will from time to time be displaced or forced through at some point or other. The water level is altered in consequence, and the Inspector sometimes misled.

In some cases it will also be found that the water will subside slightly immediately after the drain has been filled, and then remain constant. This is accounted for by the absorption of water which takes place if the drain is dry, and need not be taken into consideration unless considerable. Generally speaking, the better the materials and the general construction of the drain, the smaller is the quantity of water absorbed.

Should there be any difficulty in watching the water level, Jones' Indicator (Fig. 105) may prove useful. The indicator consists of a glass tube divided into inches and their sub-divisions, and may be connected to the stopper, with which the drain has been plugged, by a flexible tube. Once the water is at rest, the slightest leakage is readily detected, as the water level in the tube will be lowered. The chief value of the indicator, however, lies in the facility

which it offers for ascertaining the total fall of the drain from its "head" to its outlet. The fall is, of course, equal to the difference in height between the water level in the tube (when the drain is full) and the invert of the drain.

As with the smoke test, so with the water test, all results are noted, no matter whether the drains are sound or faulty.

Soil-pipes, ventilation pipes, and waste pipes may be tested in the same way by plugging their lower ends as well as all intermediate openings in the pipes—such as connections from w.c.'s and other fittings. The test is, however,

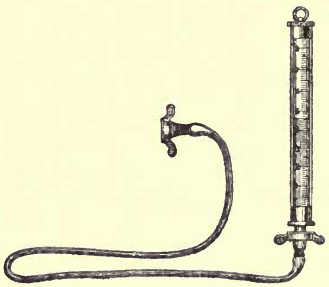


FIG. 105.

very severe if the pipe is high, as each foot in the height of the water level means, roughly, a pressure of $\frac{1}{2}$ lb. per square inch.

For this reason the water test is generally only applied to soil-pipes and such ventilation pipes as may be fixed within the house. Waste pipes and external ventilation pipes are tested with smoke, which is a sufficiently severe test for these pipes. It so happens at times that a smoke test is not practicable, and in that case an "olfactory" test may be applied. For this test oil of peppermint or paraffin oil

is often used. The test is applied by adding a quantity of one of the fluids to a bucket of hot (almost boiling) water, which is poured into the pipe through its top. If the pipe be defective, the smell will soon be perceivable, although, of course, the exact point of leakage is not disclosed. Needless to say, the test must always be applied by an assistant, and not by the Inspector, as the latter would carry the smell with him and discover imaginary leakages wherever he went. Should it prove necessary to apply the test through a closet or other fitting, the opening must be immediately closed. The operator must also remain in the apartment until the Inspector has satisfied himself as regards the soundness of the various connections. From 1 oz. to 2 oz. of oil of peppermint, or about a quart of paraffin oil, is necessary for each test.

Other olfactory tests are Burnet's, Kemp's, Kingzett's, Banner's Grenade, and others, of which some have been described in the first chapter.

Olfactory tests are most valuable in old country houses, where a bewildering network of old and new piping may be found. Many of these pipes are disused or hidden from sight, whilst the point of discharge of others cannot be found. In tracing these pipes the olfactory test is of the greatest assistance to the Inspector, especially so as the majority of the pipes will usually be found defective, and thus allow the looked-for fumes to escape. As a test proper, the smell test is of little value, however, as no pressure is applied to the pipes, which may appear perfectly sound if their defective portions are coated with dirt.

A test which is now gradually coming into use, and which will, no doubt, supersede the water test, is the "pneumatic" or compressed air test. This consists of pumping air into the drains and their connections by means

of a force-pump (see Fig. 20, Chapter I.), after all outlets have been closed. The air is compressed to any desired pressure (which is registered on a gauge attached to the pump, and which may be regulated by means of a safety valve), at which it should remain if the drains are sound. Should the pressure be reduced, the drains are leaking, and the defects must be traced in the usual manner.

A pressure of from 4in. to 5in. of water may be generally obtained in sound drains provided with efficiently "sealed" traps. If more is required (which is, of course, very desirable), each trap must be plugged at its mouth.

As with other tests, it is advisable to test the drains in sections when the air-test is applied. This will necessitate the use of only a few plugs at each operation, and will enable the Inspector to form an opinion as to which portions of the drains are defective.

The great advantage which the air test possesses over the water-test, is that the pressure applied by the former is uniform and of equal severity on each part of the drainage system, whereas it varies greatly in intensity in the case of the water-test, the lower portion of the drain having to withstand a much greater pressure than the upper end. In addition to this, the test may be applied at all times and under all conditions, without reference to weather or lack of water. A rainy day, for instance, is fatal to a water-test, as the rain will find its way into the drains and make it impossible to ascertain whether they are sound or leaking. With an air-test, on the other hand, the admission of water to the drain, be it by rain or through a waste pipe, will have no other effect than to increase the pressure within the drain. Any excessive pressure will, moreover, be immediately released by the safety valve should it be undesirable to test above any given pressure.

CHAPTER VI.

NOTES AND NOTE-BOOKS.

For the nature of the notes which should be taken at inspections, the reader is referred to the three preceding chapters. The object of the present chapter is to present the methods usually adopted for recording the results of an inspection and the way in which note-books should be kept.

In the first place, all notes taken, however brief, must be complete, clear, and intelligible. They should not only be an aid to memory, but should suffice to take its place completely, so that they may be referred to at any subsequent period and unfold all that which is ascertainable as clearly and as fully as if a new inspection were made. If the notes are taken in this manner, the Inspector will be able to speak with confidence and positiveness, whenever and under whatever circumstances he may be called upon to do so. In my own experience I have found this of the greatest importance, and have, on more than one occasion, been able to give evidence on facts ascertained at one inspection or another after a considerable time had elapsed, and after the details of many another inspection had passed through my mind.

In taking notes, the Inspector should work systematically and uniformly, to make sure that nothing is forgotten. In the house, for instance, he should devote his attention exclusively to each storey in turn. We will say that he commences in the basement. He should go into each room on that floor, and learn and note all that can be

ascertained. When he is certain that nothing has been forgotten there, he goes up to the ground floor, examines that fully (making notes the while), and then turns his attention to the first floor, and so on right up through the house and up on the roof.

With the various apparatus he must be equally systematic. Here is a closet, for instance: Note type of basin, nature of trap, mode of connection to soil-pipe, quality and quantity of flush, nature and type of cistern, overflow of cistern, floor of apartment, ventilation of apartment, ventilation of closet trap, &c. Here is a sink: Note material of which sink is made, nature and condition of overflow, condition of sink; nature, size, and materials of trap (if any) under sink; nature, size, and material of sink-waste, joints of sink-waste; points of discharge, course and ventilation of waste, &c. Nothing must be taken for granted, and nothing left to memory.

The notes should be made in a proper note-book, kept exclusively for the purpose, and never upon odd pieces of paper or old envelopes, as I have sometimes seen them. The books are lasting, and, if properly indexed, may be easily referred to. An ordinary plain note-book may, of course, be used, but there are others on the market specially compiled for drainage-inspection notes. These books are preferable to the plain ones, as they have a heading for each item comprised by the "sanitary arrangements" of a house, and thus make it difficult to forget any item. Some of the books include also a number of memoranda and tables, which may prove useful to the Inspector when he is away from any other book of reference. Pages, ruled into small squares, are also provided for such sketches as the Inspector may have to make.

No set of notes is complete which does not include a

sketch plan of the house and its drains. This should, therefore, always be made. The drains should be sketched in as accurately as surface or other indications will allow, and each gully marked on, together with the names of the wastes discharging into it. All other adjuncts to the drainage system—such as soil-pipes, rain-water pipes, inlet and outlet ventilators, inspection chambers, and disconnecting traps—must also be marked on as clearly and as near to their real positions as possible.

Should it appear necessary to change the position of any drain, or in any way to alter any portion of the sanitary arrangements, it will be well to make sketches of what exists, and the way in which the alterations should be carried out. It does not speak well for the Inspector to recommend alterations which local conditions render impossible. He should, therefore, as far as possible, decide upon his recommendations at the time of inspection, satisfy himself as to their practicability, and take notes accordingly.

Copies of two sets of notes will be found at the end of the book. The first set is copied from a proper inspection note-book, the headings being those given in the note-book. The other set has been copied from a plain note-book.

CHAPTER VII.

REPORTS.

On concluding an inspection, it is the Inspector's duty to inform his client of the result. This is done in a "Report," in which is given a description of what has been found, together with the Inspector's recommendations for the rectification of all items affecting the sanitary condition of the house.

For the couching of a report, no special rule can be laid down. The report may take the form of a letter, treating with the sanitary arrangements in general, or the items with which it treats may be formally dealt with under a separate heading for each. A complete report may precede the recommendations, or a report and a recommendation may be made upon and for each item separately. As habit is as great a factor in reporting as in any other walk of life, it will, however, be well for the Inspector to choose and adhere to one form of report only; placing, and reporting upon, the various items in a given order—in short, systematically. This will assist him materially in making the report complete, and in avoiding the omission of any item.

Whatever their form, however, the reports should be concise and lucid. Whilst brevity is to be aimed at, clearness must not be sacrificed, and it is well to bear in mind that the majority of the reports go to householders—laymen—to whom they should be as comprehensible as to technical men. Repetition must be studiously avoided, but nothing,

however trifling, forgotten. Each gully, rain water pipe, ventilator, each and every chip from the block, "Sanitary Arrangements," must have its place in the report, and be approved of or condemned upon its merits. If condemned, the reasons for so doing must be stated.

The recommendations must not be too sweeping, for, although it is always well to aim at theoretical perfection, practical safety will meet numerous cases of short tenancies and limited means. Such circumstances must be taken into consideration, and allowed to modify the Inspector's recommendations *so far as they legitimately may.* Alternative remedies may also be given, or the report so expressed that the reader may readily distinguish between vital defects and desirable improvements, when he will be at liberty to defer or reject any of the recommendations made. As an example may be cited the disconnection of the house drains from the sewer. For this the disconnecting trap is imperative, but the surrounding chamber, usually recommended, merely useful for access to the drain on future occasions. The latter may therefore well be left out of the drainage system without any risk to the health of the inmates of the house.

Unless there are special reasons for so doing, the Inspector must also avoid recommending any particular maker's appliances. There are many manufacturers and many appliances of equal merit, and it would therefore be unjust to recommend one above another. Nor will it be difficult for the Inspector to avoid doing so, as he is, of course, impartial, and has no interest in any patents, or manufacturing and trading firms.

A plan, not necessarily to scale, should be appended to the report. On it the existing drains and their appurtenances should be marked in firm black lines, the proposed

alterations being shown by red lines. This will make the report clearer to the average reader, who, perchance, knows little or nothing of the house and its, only too often insanitary, "Sanitary Arrangements." Sketches may also be added in the margin of the report to elucidate any particular point.

The appended forms of report may prove useful to the Inspector as suggestions for the drafting of his reports. They each refer to the same house, and contain the same information, whilst the attached sketch-plan may be used with either.

CHAPTER VIII

THE SUPERVISION OF ALTERATIONS.

COMPETENT and disinterested advice with regard to alterations in, or the reconstruction of, the drainage system, should either of these be necessary, is very important; but that is not all. In drainage work nothing must be taken on trust, for in no other department of human industry is scamped work so common or so difficult to detect when finished as in this.

Were the contractor left to carry out the alterations unwatched, it would be almost impossible to know whether the instructions given in the specifications and plans had been properly carried out, as the work is soon buried and out of sight; and if it were subsequently found that the work had been improperly carried out, even though the contractor could be compelled to replace it with satisfactory work, the inconvenience and delay of this is better avoided by proper supervision during construction. It is important, therefore, that the Inspector should be constantly at hand when any work is progressing.

The duties of supervision commence with the excavation. Here it must be seen to that the contractor does not interfere with gas and water pipes, and that he obtains the right depth and width of trench. Should he go too deep, the excessive depth, as also all unevenness in the bed, must be filled in with concrete and not with earth. This must never be used for the purpose, as it will not provide a firm foundation, however well rammed. The trench must not be too wide, as this will involve unnecessary disturbance of the

ground. Nor must it be too narrow, or there will not be sufficient room for the pipe-layer to make good joints. Supervision at this stage of the work will also enable the Inspector to note any unforeseen underground condition which might require a modification in the plans. It must also be seen that the timbering of the trenches is in accordance with the requirements of the soil, and that due precautions are taken to prevent accidents to life or property.

The next duty will be to examine and, where necessary, test the materials brought upon the ground. Each bag or barrel of cement is examined to ascertain if it is of the required make and quality, and to see that it is not caked by moisture. An eye is also kept on all bricks, sand, and ballast, to see that they are of the required quality. Drain pipes must be carefully examined and tested. Should stoneware drains have been specified, it must be seen that the pipes are strong, even and regular in thickness, properly burned, accurate in form, perfectly smooth inside and glazed. Care must also be taken to see that fire-clay pipes are not substituted. Stoneware pipes are usually distinguishable from these in that they are of a pale buff colour, while fire-clay pipes are of various shades of reddy brown and sometimes grey. When struck with a hammer, a stoneware pipe has a metallic sound, which is not the case with an earthenware pipe. To ascertain the quality of the pipes, they should be dried until they cease to lose weight, and then submerged in water for not less than twenty-four hours. They should then be removed, dried and re-weighed. The best pipes will be those whose weight has changed least, that is, those which have absorbed the least quantity of water.

Each stoneware pipe should be tested, before being laid, by placing two or three together in a vertical position upon

a bed of stiff clay, their joints being similarly made. They should then be filled with water. If the pipes are porous, the water will penetrate the pores of the material of which the pipes are made, and show itself on the outer surfaces of the pipes in the form of "sweat." Any pipes which are thus proved to be permeable are unfitted for sewage drains and must be discarded, as they will allow liquids to escape through them if subjected to even the smallest of pressures.

Should iron piping be used, it must be seen that it is straight, accurate in form, of even thickness, and provided with strong sockets which leave a good margin all round for caulking up. The pipes must also be properly coated by some anti-corrosive solution or glass lining, and must be free from cracks or faults. To test the pipes as to their soundness, each should be struck with a hammer. If a jarring sound is emitted, it is a sign that there is a flaw in the pipe. Should it, on the other hand, "ring," it may be taken for granted that the pipe is sound. The thickness of a few pipes should also be measured (or the pipes may be weighed) to see that they are of the substance specified. Junctions, bends, and set-offs must correspond with the straight pipes in all respects.

Lead pipes and sheet lead should also be weighed or measured to ascertain that they are of the required strength. The relation of the weight to the thickness of lead is set forth in the following tables:—

Thickness of lead in inches (approximately)	$\frac{1}{20}$	$\frac{1}{16}$	$\frac{1}{12}$	$\frac{3}{32}$	$\frac{7}{64}$	$\frac{1}{8}$	$\frac{9}{64}$	$\frac{5}{32}$
Weight of lead in pounds per foot super...	3	4	5	6	7	8	9	10

Weights of Lead Pipes per 10ft. Length.

Internal diameter of pipe.	Thickness equal per superficial foot to that of sheet lead of these weights.				
	5 lb.	6 lb.	7 lb.	8 lb.	10 lb.
2in.	27	33	39	45	57
2½in.	34	41	48	55	70
3in.	41	49	57	66	83
3½in.	47	57	67	76	96
4in.	54	65	76	87	109

Whenever a length of drain has been laid, it must be seen that it is perfectly straight and of even fall. The former can be accomplished by the eye or by using a line. The latter must be done by the aid of boning rods and sight rails. When the joints have "set," the drain must be

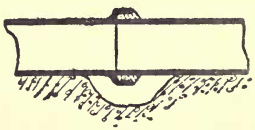


Fig. 106.

tested under pressure by the pneumatic or hydraulic tests, applied in the manner described for old drains, a handhole (as in Fig. 106) having been left round each joint to facilitate inspection. Should the pneumatic test be adopted, and the drain is proved faulty, the defects must be traced by the application of smoke. With the hydraulic test, the leakages will be apparent by the oozing or flowing of water through

the defective portions. All defects must be made good and the drain re-tested until the whole is proved to be perfectly tight, when it may be covered in and then again tested to ascertain that no damage has been done in filling in the trench. It is also a good plan to keep the drains charged with water or compressed air whilst the trenches are being filled, as any damage done to the pipes or joints, will then be detected as soon as it is done, and before the trench has been completely filled. No treading or punning should be permitted until the drain has been covered in to a depth of 2ft.

Well-laid stoneware drains of good quality, should be able to withstand a pressure of from 4 lb. to 5 lb. per square inch,

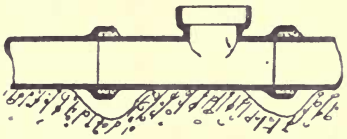


FIG. 107.

but it is not desirable to subject them to a greater pressure. With the pneumatic test, even a smaller pressure will suffice, as it is more difficult to obtain an air-tight than a water-tight joint, and it will often be found that a drain which has been proved slightly defective by the pneumatic test, will be found sound under a hydraulic test applied at a higher pressure. Cast iron drains with caulked lead joints are capable of withstanding a pressure of from 80 lb. to 100 lb., but it will generally suffice if they are tested up to a working pressure of from 5 lb. to 10 lb. Should the hydraulic test be applied, and the drain is too long or too steep to be tested in one operation, on account of the excessive pressure that would be brought to bear upon the pipes at the lower end,

it is desirable to test it in sections—junction pipes having been inserted for the purpose (as in Fig. 107) where necessary. Great care must, however, be taken to see that these junctions are properly sealed before the drain is covered in. In cases where a section to be tested occurs between two manholes, the drain should be plugged at both ends (as in Fig. 108), a tube or indicator (see Fig. 105) being fixed to the plug on the upper end of the drain to give the "head" of water necessary to produce the pressure to which it is desired to test the drain. By this means, any slight leakage is readily detected, owing to the perceptible

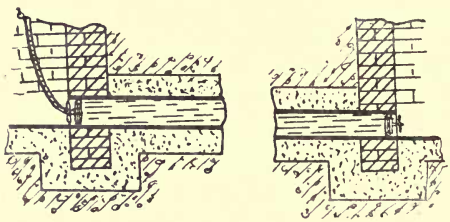


Fig. 108.

lowering of the water level in the tube; whereas, if the upper manhole were partially filled with water, it would require a considerable leakage to cause any noticeable difference of level over the large area of water which would be exposed in the manhole. The manholes should subsequently be tested separately to ascertain that the joints between the drains, channels, and benchings are perfectly water-tight and the sides of the manholes impervious.

Where the drains have to be embedded in concrete, they should first be tested and made thoroughly tight in themselves and subsequently covered with concrete.

Equal care must be exercised to make sure that the joints of soil, waste, and ventilation pipes are sound, and that the fitments within the house are well fixed and thoroughly connected to their wastes.

In general, the Inspector must see that the work is carried on with proper materials and apparatus and by proper methods; and strictly in accordance with the specifications and plans, in which all necessary details and instructions must be given. The Inspector must also see that the labourers are efficient and sufficient and that the work is pushed on with all due expedition to ensure its completion within the prescribed time.

APPENDIX TO CHAPTER VI.

(Copies of Notes.)

No. 1. Date: *February 29th*, 1898.

For: A. Client, Esq.

At: "*Blank House*," *Ashton-on-Ripple.*

OUTFALL OF DRAINAGE.

To two cesspools (the first overflowing into the second), about 90 yards from house. No. 1 cesspool, 7ft. 6in. diameter, and 5ft. deep; No. 2 cesspool, 6ft. 6in. diameter, and 4ft. deep below outlet. Both constructed of brickwork with open joints. No provision at outlets for retaining solids. Cesspools overflow into a ditch, thence into river Ripple, some 200 yards distant. Cesspools covered with stone slabs.

INSPECTION CHAMBERS.

None.

DISCONNECTING TRAP.

None.

FRESH-AIR INLET.

None.

MAIN DRAIN.

Of 6in. socketed stoneware pipes with cement joints. Jointing defective. The pipes do not meet properly, and present ridges inside the drain. Fall good (about 1 in 40). Depth of drain averages 7ft. Drains very dirty.

BRANCH DRAINS.

Of 4in. and 6in. pipes, as above. Junctions with main drain very sharp.

RAIN-WATER DRAINS.

Of 4in. stoneware pipes. The drains join the sewage drains direct. The drain from spring in basement is constructed of 6in. stoneware pipes without sockets or joints, and joins the sewage drain direct.

RAIN-WATER PIPES.

All but one join the drains direct. The exception discharges over a surface trap (see plan). The pipe near the conservatory and that near the scullery are cracked and leaking. The pipe at the back of the tool-shed is blocked. None of the pipes are jointed.

SOIL-PIPES.

One near pantry. Constructed of 4in. light iron pipes, partly jointed with putty and partly unjointed. Continued to roof by 2½in. zinc piping.

VENTILATION PIPES.

None proper, but most rain-water pipes act as such. Also per 2½in. zinc piping off soil-pipe. The outlet of this is close to a bedroom window. A zinc cap has been fixed on the outlet of the latter pipe.

GULLY TRAPS.

All gullies outside the house are of "cesspool" type. Their "seal" averages ½in. All the traps are full of detritus and have sunk, leaving a space between their upper edge and their coping stones; waste water consequently soaks into walls of house. The two traps in the passage are of the "bell" type.

GREASE TRAP.

None.

W.C.'s AND SLOP HOPPERS.

W.C. on ground floor of "wash-out" type. Flushed by own (valve) cistern, with overflow to outside. Flush poor. Closet basin dirty. *W.C. on first floor.*—Same as above, but with syphon cistern. The cistern overflows through its syphon. Flush good. The connection to soil-pipe is cracked. *W.C. in outhouse.*—"Cottage" hopper with separate trap. Connection to drain faulty. Own valve cistern with overflow to outside. Flush weak (through 1in. flush pipe). Closet basin and trap dirty. Closet floor tiled. No slop hoppers in house.

URINALS.

None.

LAVATORIES AND THEIR WASTES.

Lavatory on ground floor. — Outlet from fitting 1in. in diameter; trap (of drawn lead), 2in. Discharges into pantry-sink waste through 2in. lead piping. No ventilation pipe off trap. Waste-pipe battered and leaking. Lavatory overflows through five small holes. *Lavatory on first floor.*—Basin and overflow good. Discharges trapped into same hopper-head as bath. Waste-pipe about 10ft. long and unvented.

BATHS AND THEIR WASTES.

Bath on first floor is untrapped. Discharges into a hopper-head outside window (which also receives lavatory waste), thence direct into drain through 2in. light iron piping with loose joints. No casing round bath, which is of cast iron and painted. Bath overflows through small holes at foot end. No "safe" under bath.

SINKS AND THEIR WASTES.

Scullery sink (in basement) of sandstone, filthy in consequence. Sink trapped by shallow bend in waste. Waste of 1½in. drawn lead and discharging over gully in window area. Much of the discharge soaks into the walls of the latter. Waste unvented. *Pantry sink* (on ground floor) of glazed fire-clay, with open overflow pipe. Trapped by 1½in. drawn lead trap, and discharging over gully trap outside through 1½in. drawn lead piping. Trap provided with a 1½in. puff pipe.

WATER SUPPLY.

From mains. Water exceedingly hard (about 18 deg.). Hot-water boiler and pipes contain much "fur" in consequence.

FILTER.

None. "Pasteur" filter can be fixed in pantry and fed by branch off main.

CISTERNS.

A covered galvanised iron cistern supplies bath and hot-water cistern. Cistern overflows into rain-water gutter. The hot-water cistern abuts on the sides of the roof, and is exposed and liable to freeze.

RESULT OF WATER TEST.

None applied.

RESULT OF SMOKE TEST.

Drains leaking considerably throughout. Smoke issued through most of the soil-pipe joints and through the rain-water pipes; also through joints of pipes with first-floor water-closet and water-closet in outhouse. The smoke also found its way into the basement through the drain from spring.

LIGHTING OF LIVING ROOMS.

By gas.

VENTILATION OF ROOMS.

None. Ventilators can be inserted in chimney breasts.

VENTILATION OF WATER-CLOSET AND SIMILAR APARTMENTS.

Good, with exception of water-closet in outhouse, which is without air and light. A casement window can be inserted in the back wall.

FLOORS OF LOWEST ROOMS.

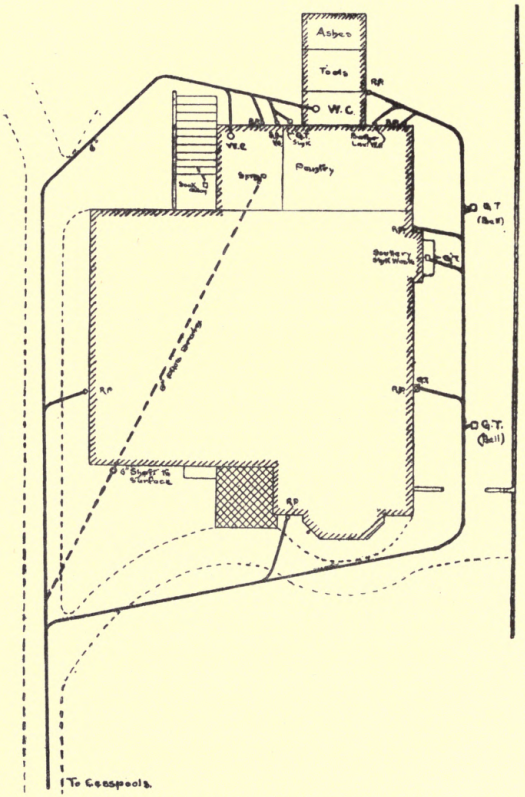
All in basement. With exception of kitchen floor, all are of concrete and cement. Kitchen floor of tiles, set in cement. Many of the joints of this floor have cracked, and should be touched up.

GENERAL REMARKS.

There is a powerful spring under the house, close to the foot of the back steps. The spring overflows at rare intervals and floods the basement. To take off this water a gully trap has been fixed near the steps. Its discharge is meant to soak into the ground.

The hot-water pipes are almost choked with fur, and must be renewed.

EXPENSES.—


Asbo
Tools
W.C.
W.C.
Poultry
Dung
Trough
G.T.
(Bath)
Sink
Sink
Laundry
Drain
Soil Pipe
Rain Water Pipe
Rain Water Pipe
Rain Water Pipe
Rain Water Pipe
G.T.
(Bath)
Rain Water Pipe
Rain Water Pipe
Rain Water Pipe
Rain Water Pipe

No. 2. DATE: *June 31st*, 1898.

FOR: A. DASH, ESQ.

AT: 27, *Macadam Road, W.*

BASEMENT.

Floors.—Of concrete, rendered in cement. Satisfactory throughout.

Scullery sink.—Of lead-lined wood. The lead is buckled (through the use of hot water). Sink overflow open and clean. Waste trapped but not ventilated, discharges into a flush-rim gully outside. Trap and waste of 1½in. drawn lead. Trap syphoned by the discharge of the flushing tank.

Flushing tank. — Forty gallons capacity. Doulton type. Fixed in scullery, and discharging into scullery sink waste. —Satisfactory.

Sink in housekeeper's room.—Of wood, lined with tinned copper. No overflow. Trapped by 1½in. drawn lead, discharges over surface trap in area, and is ventilated by a "puff" pipe.

Servants' w.c.—Near coal cellar in front area. "Wash-down" pedestal basin. Own 2½-gallon cistern (syphon type) with overflow to open. Flush good. Closet basin and trap very dirty.

GROUND FLOOR.

Pantry sink.—Of glazed stoneware. Overflows through three slits in side of sink. Waste and trap of 1½in. drawn lead. Discharges into bath waste. Trap vented by 1½in. lead anti-syphonage pipe branched into bath waste vent.

W.C.—North-British Plumbing Company's valve closet, in good condition. Lead safe under; this discharges into open with flap-valve on outlet of pipe. Trapped by "anti-D" trap, and discharging into soil-pipe from first-floor w.c. Trap ventilated by 2in. anti-syphonage pipe branched into that from closet above. Casing round closet shows signs of decay.

FIRST FLOOR.

Bath.—Enamelled iron bath. Overflows through standing waste pipe, which is inaccessible. Waste valve does not fit properly, and does not, consequently, allow water to remain in bath. Hot-water tap leaks. Casing round bath nailed and difficult to take down. Safe under bath discharges into open, with flap-valve on outlet of pipe. Bath trapped in itself. Discharges over surface-trap in back area through 2in. drawn lead waste continued to eaves as vent. Anti-syphonage pipe off trap branched into bath waste vent.

Lavatory.—"Loco" lavatory with self-cleansing overflow, 1½in. lead waste and trap. Discharges into bath waste. Trap vented into anti-syphonage pipe from bath trap. Lavatory in same room as bath.

W.C.—"Wash-down" type. Good flush from own 2½-gallons syphon cistern. Cistern overflow to open. Anti-syphonage pipe (2in. lead) taken off trap and continued to above ridge of roof.

OUTSIDE.

Soil-pipe.—Of 8 lb. drawn lead, 3½in. in diameter. Wiped joints. Continued full bore to 3ft. above ridge of roof as ventilation pipe. Copper-wire guard on outlet. Pipe should be protected at foot, being liable to be damaged.

Rain-water pipes.—Of galvanised iron with red-lead joints. All discharge over surface traps.

Surface traps.—All good syphon traps. Most traps dirty, however.

Drains.—Of 4in. heavy iron pipes with run lead joints. Pipes glazed internally. Sound on applying water test. Drains discharge into sewer in Macadam-road. Drains trapped in manhole in front area.

Control.—Drains provided with cast iron lever-locked inspection chambers, set in glazed brick manholes, in front and back areas. Manholes covered with iron manhole covers and frames.

Ventilation inlet.—Through 4in. pipe branched into inspection chamber in front area. Inlet guarded by mica flap valve, which is broken.

GENERALLY.

Water supply.—Direct from main. Cistern in attic used only for hot water. Cistern of galvanised iron and covered.

Filters.—Two. One spongy iron, the other carbon.

Lighting.—Living rooms lit by electricity.

Ventilation.—Rooms ventilated through Tobin tubes, and Ching's silk flap ventilators fixed in chimney breasts.

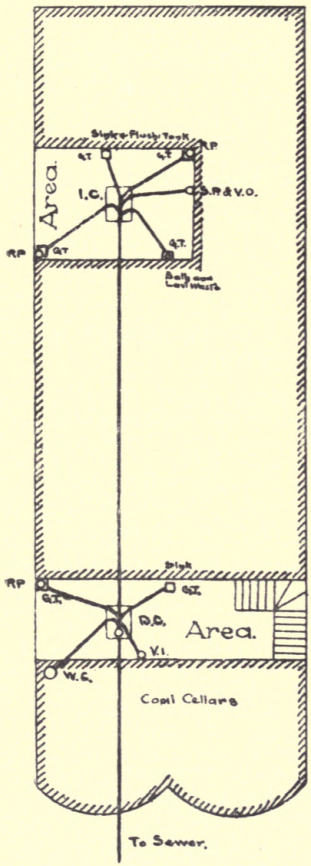

Area.
I.C.
R.P.
G.T.
R.P. & V.O.
Bath room
Area.
D.D.
V.I.
W.C.
Coal Cellars
To Sewer.

FIG. 110.

APPENDIX TO CHAPTER VII.

(COPIES OF REPORTS.)

(FORM NO. 1)

REPORT

UPON THE SANITARY ARRANGEMENTS OF "OAKLEIGH," YORKS.

ITEM.	REPORT.	RECOMMENDATION.
Sewage outlet.	The drains discharge into the public sewer.	Satisfactory.
Drains.	The main drain is constructed of 9in. stoneware pipes, with clay joints. The branch drains are of similar materials, and 6in. in diameter. The drains are all of excessive size, and the available flow of sewage insufficient to clear them of deposits. The jointing material is unsuitable and unreliable, being liable to peforation by by worms and roots, and to be washed out of the sockets by the flow within the drains. On applying the smoke test, smoke issued freely through the ground, proving the existence of grave defects.	The whole of the existing drains, and all contaminated soil around them, must be removed, and new drains, constructed of 4in. glazed stoneware pipes with cement joints, substituted The new drains should be laid upon a concrete foundation, in the positions marked upon the annexed plan. The new drains must be proved to withstand the water test before and after being covered in.
Disconnection.	The drains are apparently untrapped from the sewer. Sewer gas is thus allowed to charge the drains and their connections.	A 4in. disconnecting trap should be fixed on the drain where shown on plan.

ITEM.	REPORT.	RECOMMENDATION.
Control.	No means of access are provided. These are desirable for cleansing the drains and in case of stoppage.	Inspection chambers (each 3ft. by 2ft. 6in.) should be built at the point of disconnection and at the side of the house, as marked on the plan. The chambers should be built of brick in cement, the interiors of the chambers being rendered in cement. The chamber bottoms should be formed by access pipes with air-tight covers. The branch drains must be led into these, as shown on plan. The chambers must be covered, at the ground-level, with air-tight, removable iron covers and frames.
Ventilation.	No special provision has been made for the ventilation of the drainage system, which, together with the sewer, is at present freely ventilated close to windows and under the slates of the roof, through the rain water pipes.	An air-inlet to the drains should be provided through a 4in. branch drain off the access pipe in the disconnecting chamber. An outlet ventilation pipe should be provided by continuing the soil-pipe, full bore, to above the ridge of the roof. A copper wire guard should be fixed on the outlet of the pipe to prevent obstruction.
Soil-pipe.	This is constructed of light iron pipes with putty joints. These materials are unreliable and the joints defective.	The soil-pipe should be re-constructed with 4in. iron piping (weighing 30 lb. per yard) jointed with hemp and molten lead, and coated with Dr. Angus Smith's anti-corrosive solution.

ITEM.	REPORT.	RECOMMENDATION.
Rain-water pipes.	Four of these discharge direct into the drains and the fifth into the soil-pipe, thus acting—improperly—as ventilation pipes.	All five pipes should be led to discharge over surface traps.
Surface traps.	Of these there are two, one taking the discharge from the scullery sink and the other that from the bath and the lavatory. Both are of "cesspool" type, and retain filth. They are therefore insanitary.	Surface traps of "syphon" type should be substituted for the present traps, and additional traps fixed where shown on plan.
W.C.	This is of "wash-down" pedestal type. It is efficiently flushed through a water-waste preventing cistern, snd leaves nothing to be desired in general arrangement.	Satisfactory.
Bath.	The bath is untrapped, and therefore allows noxious gases (arising from decomposing deposits in the waste pipe and the surface trap over which it discharges) to enter the house.	A 2in. drawn lead trap, with cleansing cap, should be fixed under the bath, and led to discharge under the grating of the proposed new surface trap outside by means of a 2in. (8 lb.) drawn lead waste, continued full bore to above the eaves as a ventilation pipe.
Lavatory.	Ditto, ditto.	The lavatory should be trapped by a 1½in. drawn lead trap, with cleansing cap, and made to discharge into the above-recommended new bath waste. An anti-syphonage pipe should be taken off this trap and branched into the bath-waste vent a few feet above the level of the trap.

Item.	Report.	Recommendation.
Scullery sink.	Being of sandstone, this sink absorbs grease and other impurities. The sink is trapped, and discharges under the grating of a surface trap outside the house.	A glazed fire-clay sink should preferably be substituted.
Ash-pit.	This is well constructed, covered and ventilated, and will not become offensive if frequently cleaned.	Satisfactory.
Privy.	The privy is objectionable and unnecessary.	Substitute a "washdown" pedestal closet, with three gallons syphon flushing cistern, and 1½in. flush pipe. The overflow from the cistern to be carried through the wall, and made to discharge in the open. Failing this, cleanse, disinfect, and disuse.
Water supply.	Direct from mains.	Satisfactory

[Form No. 2.]

REPORT.

DEAR SIR,—

Re "OAKLEIGH," YORKS.

In accordance with your instructions of the 9th inst., I have to-day inspected and tested the Sanitary arrangements of the above, and now beg to report as follows:—

The drains, which discharge into the public sewer in the road, are constructed of 9in. stoneware pipes with 6in. branches. Both these dimensions are excessive, and the available flow of sewage insufficient to clear the drains of deposits. The joints of the drains are of clay, which is an unsuitable and unreliable material, as it is liable to be washed out of the sockets by the flow in the drains, and to perforation by worms and roots.

On applying a smoke test, smoke issued freely through the ground, thus proving that grave defects exist. These are especially dangerous, as the drains appear to be untrapped from the public sewer.

No special provision has been made for the ventilation of the drainage system, which, together with the sewer, is at present freely ventilated, close to windows and under the slates of the roof, through the rain-water pipes, all of which are connected to the sewage drains direct. Foul air is also permitted to escape through the joints of the soil-pipe, which is constructed of light iron pipes with putty joints. These materials are both unreliable.

The surface traps, of which there are two, are of "cesspool" type, and retain filth; they are therefore insanitary.

The water-closet is of "wash-down" pedestal type. It is efficiently flushed through a water-waste preventing cistern, and leaves nothing to be desired in general arrangement.

The bath and lavatory are both untrapped, and therefore allow noxious gases—arising from decomposing deposits in the waste pipes and the surface trap over which they discharge—to enter the house

The scullery sink, being of sandstone, absorbs grease and other

impurities. It is, however, trapped, and discharges under the grating of a surface trap outside the house.

The ashpit is well constructed, covered, and ventilated, and need not become offensive if frequently cleaned. The privy adjoining is, however, objectionable and unnecessary.

The water supply, which is derived from the mains direct, is satisfactory.

To render the house safe as regards Sanitation, the following recommendations should be carried out:—

The whole of the existing drains, and all contaminated soil around them, must be removed, and new drains, constructed of 4in. glazed stoneware pipes, with cement joints, substituted. The new drains should be laid upon a concrete foundation in the positions marked on the annexed plan. They must be proved to withstand the water test before and after being covered in. A 4in. disconnecting trap must be fixed on the drains—in the position shown—to cut off sewer-gas from the drains.

To provide access for cleansing or in case of stoppage, inspection chambers—each 3ft. by 2ft. 6in.—should be built at the point of disconnection and at the side of the house—see Plan. The chambers to be of brick in cement, the interiors of the chambers being rendered in cement. The chamber bottoms should be formed by access pipes with air-tight covers. The branch drains must be led into these, as shown on the plan. The chambers should also be covered at the ground level with air-tight removable iron covers and frames. An air-inlet to the drains should be provided through a 4in. branch drain off the access pipe in the disconnecting chamber.

The soil-pipe should be reconstructed with 4in. iron piping—weighing 30 lb. per yard—jointed with hemp and molten lead, and coated with Dr. Angus Smith's anti-corrosive solution. The piping should be continued full-bore to above the ridge of the roof as an outlet ventilation pipe. A copper wire guard, to prevent obstruction, should be fixed on its outlet.

Surface traps of "syphon" type should be substituted for the present "cesspool" traps, and additional traps fixed where shown on plan. All rain-water pipes must be led to discharge into these.

A 2in. drawn lead trap with cleansing cap should be fixed under the bath, and led to discharge under the grating of the surface trap outside by means of a 2in. (8 lb.) drawn lead waste, continued full bore to above the eaves as a vent.

The lavatory must be trapped by a 1½in. drawn lead trap, with

cleansing cap, and made to discharge into the proposed new bath waste. An anti-syphonage pipe should be taken off this trap and branched into the bath waste vent a few feet above the level of the trap.

A glazed stoneware sink should preferably be substituted for the present sandstone sink.

For the privy, substitute a "wash-down" pedestal closet with three-gallons syphon flushing cistern and 1½in. flush pipe. The overflow from the cistern to be carried through the wall and made to discharge into the open. Failing this, cleanse, disinfect, and disuse the privy

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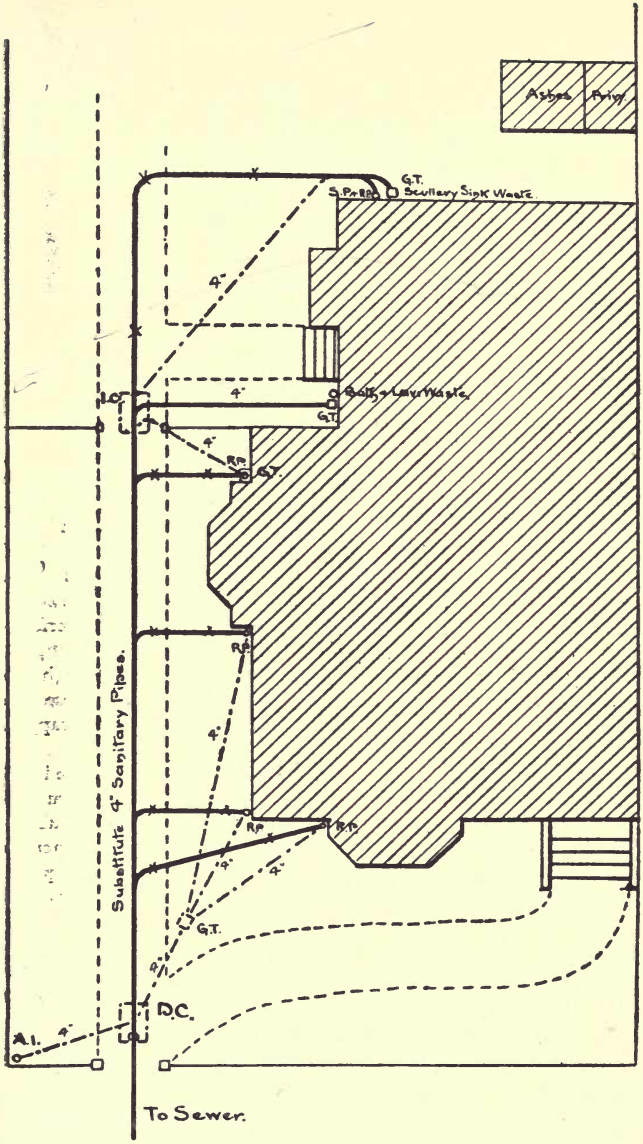

REFERENCE.—Inspection Chamber, I. C. Disconnecting Do., D. C. Inlet, A. I. Soil Pipe, S. P. Rain Pipe, R. P. Gully (surface) Trap, G. T. Existing Drains shown thus: ———— Drains to be removed shown thus: *——* New lines of Drains shown thus: - - - - - -

(Form No. 3.)

REPORT

UPON THE SANITARY ARRANGEMENTS OF "OAKLEIGH," YORKS.

Drains. The drains, which discharge into the public sewer in the road, are constructed of 9in. stoneware pipes with 6in. branches. Both these dimensions are excessive, and the available flow of sewage insufficient to clear the drains of deposits. The joints of the drains are of clay, which is an unsuitable and unreliable material, as it is liable to be washed out of the sockets by the flow in the drains, and to perforation by worms and roots.

On applying a smoke test, smoke issued freely through the ground, thus proving that grave defects exist. These are especially dangerous, as the drains appear to be untrapped from the public sewer.

The whole of the existing drains, and all contaminated soil around them, must be removed, and new drains, constructed of 4in. glazed stoneware pipes, with cement joints, substituted. The new drains should be laid upon a concrete foundation in the positions marked on the annexed plan. They must be proved to withstand the water test before and after being covered in.

Disconnection. The drains are apparently untrapped from the sewer. Sewer gas is thus allowed to charge the drains and their connections.

A 4in. disconnecting trap must be fixed on the drains, in the position shown, to cut off sewer-gas from the drains.

Control. No means of access are provided. These are desirable for cleansing the drains, and in case of stoppage.

Inspection chambers—each 3ft. by 2ft. 6in.—should be built at the point of disconnection and at the side of the house—see Plan. The chambers to be of brick in cement, the interiors of the chambers being rendered in cement. The chamber bottoms should be formed by access pipes with air-tight covers. The branch drains must be led into these, as shown on the plan. The chambers should also be covered at the ground level with air-tight removable iron covers and frames.

Ventilation. No special provision has been made for the ventilation of the drainage system, which, together with the sewer, is at present freely ventilated, close to windows and under the slates of the roof, through the rain-water pipes.

An air inlet to the drains should be provided through a 4in. branch drain off the access pipe in the disconnecting chamber. An outlet ventilation pipe should be provided by continuing the soil pipe full-bore to above the ridge of the roof. A copper wire guard, to prevent obstruction, should be fixed on its outlet.

Soil-pipe. This is constructed of light iron pipes, with putty joints. These materials are unreliable, and the joints defective.

The soil-pipe should be reconstructed with 4in. iron piping—weighing 30 lb. per yard—jointed with hemp and molten lead, and coated with Dr. Angus Smith's anti-corrosive solution.

Rain-water pipes. Four of these discharge direct into the drains, and the fifth into the soil-pipe, thus acting—improperly—as ventilation pipes.

All five pipes must be led to discharge over surface traps.

Surface traps. The surface traps, of which there are two, are of "cesspool" type, and retain filth; they are therefore insanitary.

Surface traps of "syphon" type should be substituted for the present "cesspool" traps, and additional traps fixed where shown on plan.

W.C. The water-closet is of "wash-down" pedestal type. It is efficiently flushed through a water-waste preventing cistern, and leaves nothing to be desired in general arrangement.

Bath and lavatory.

The bath and lavatory are both untrapped, and therefore allow noxious gases—arising from decomposing deposits in the waste pipes and the surface trap over which they discharge—to enter the house.

A 2in. drawn lead trap with cleansing cap should be fixed under the bath, and led to discharge under the grating of the surface trap outside, by means of a 2in. (8 lb.) drawn lead waste, continued full bore to above the eaves as a vent.

The lavatory must be trapped by a 1½in. drawn lead trap, with cleansing cap, and made to discharge into the proposed new bath waste. An anti-syphonage pipe should be taken off this trap and branched into the bath waste vent a few feet above the level of the trap.

Scullery sink.

The scullery sink, being of sandstone, absorbs grease and other impurities. It is, however, trapped, and discharges under the grating of a surface trap outside the house.

A glazed stoneware sink should preferably be substituted for the present sandstone sink.

Ash-pit.

The ashpit is well constructed, covered, and ventilated, and need not become offensive if frequently cleaned.

Privy.

The privy is objectionable and unnecessary.

Substitute a "wash-down" pedestal closet with three gallons syphon flushing cistern and 1½in. flush pipe. The overflow from the cistern to be carried through the wall and made to discharge in the open. Failing this, cleanse, disinfect, and disuse the privy.

Water supply.

The water supply, which is derived from the mains direct, is satisfactory.

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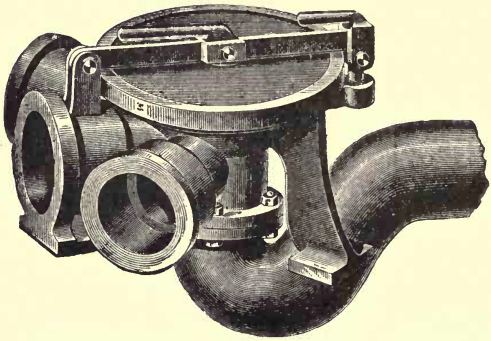

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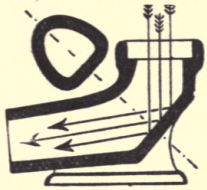

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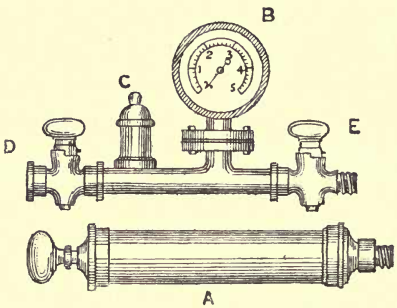

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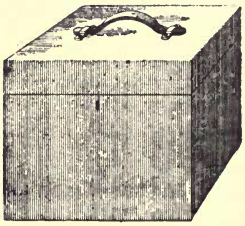

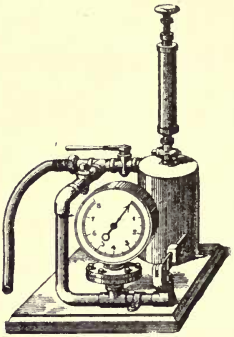

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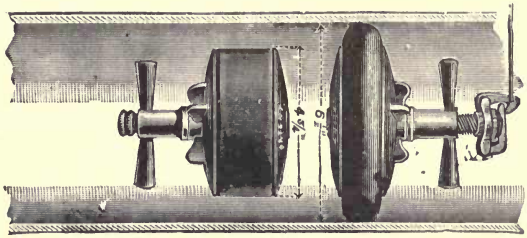

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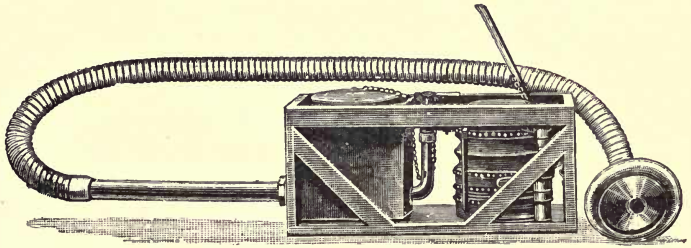

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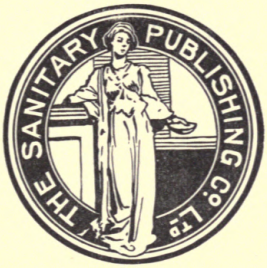

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